Circuit Description

GENERAL

The repeater facilities communication between one station to another. It receives a relatively week signal on an assigned frequency in the 132 to 178 MHz band, demodulates the signal to baseband, and retransmits baseband information at a selected level between 25 to 125W on the assigned transmitter VHF frequency between 132 and 178 MHz. The level adjustment is continuous within the 25 to 125W range.

In normal operation, no external controls for setting transmitter power and frequency are available to an operator. Only manufacturer, installation or maintenance personnel can make or change these settings using a personal computer and custom software which are not a part of the operating equipment.

The transmitter subsystem consists of three assemblies. They are the exciter, the high power amplifier and the RF interface. The exciter is at the head of the transmitter RF chain, and it generates a low level of FM signal that is at the fundamental frequency of the transmitter. The high power amplifier boosts the level of the signal produced by the exciter to a selected, controlled level between 25 and 125W. The RF interface assembly provides an interface between the transmitter and the power, modulation, monitor and control functions of the repeater.

The exciter generates a frequency modulated signal at the fundamental transmitter frequency with an output level required to drive the high power amplifier. To generate the fundamental transmitter frequency, the exciter incorporates phase lock technology to control the stability of the internal voltage oscillator, VCO, with a very stable reference signal from an internal temperature compensated crystal controlled oscillator, TCXO. The synthesizer produces an output signal at the assigned transmitter frequency. A voltage-controlled oscillator, VCO, operating at the fundamental transmitter frequency produces this signal. A phase locked loop, PLL, controls and stabilizes the VCO frequency and locks it to the frequency of a high stability signal derived from a TCXO of 1.0 PPM located in the exciter assembly. To suppress frequency pulling during transmission, the exciter isolates the frequency determining circuit from the rest of the transmitter chain with RF buffer amplifiers.

Multilevel voltage regulation isolates the frequency determining circuits from disturbances produced at the primary power source. As a part of the multilevel regulation strategy, the exciter provides internal regulation of critical voltage to ensure frequency stability and noise immunity from external noise sources.

When turning on the repeater, the processor on the main processor card, MPC, down loads the preprogrammed frequency information to the synthesizer integrated circuit, IC, located in the exciter. The synthesizer stores its respective frequency programming information in an internal register. Normally, there is no further update of the stored information. If the synthesizer becomes unlocked, it sends a signal to the MPC which turns off transmission to prevent interference with other channels.

EXCITER

VCO

The Voltage-Controlled Oscillator (VCO) is formed by Q101, associated circuitry and High-Q indicator L102. The VCO oscillates in a frequency range from 132-178 MHz. Biasing of Q101 is provided by R102, R103 and R104. An AC voltage divider formed by C107 and C108 initiates and maintains oscillation. C106 couples Q101 to the High-Q inductor. RF choke L103 completes the DC bias path to ground.

The VCO frequency is controlled in part by DC voltage across varactor diode D101. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. The control line is RF isolated from tank circuit by choke L101. The amount of frequency change produced by D101 is controlled by series capacitor C102.

The frequency is modulated in a similar manner. The transmit audio/data signal is applied across varactor diode D102 to vary the VCO frequency at an audio rate. C104/C105 in series with D102 determine the amount of modulation produced by the audio signal.

VCO BUFFER

Q102/Q103 form a cascade-connected buffer circuitry. DC bias is produced by R107, R108, R109 and R1212. A signal oscillated at Q101 is DC cut and adjusted by C107 and fed into the buffer. An output from RF choke L104 passes through an adjustment circuit consisting of C114/C119.

VCO/TCXO FREQUENCY MODULATION

Both the VCO and TCXO are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U403 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (at the lower audio frequencies inside the closed loop bandwidth of the synthesizer). If only the TCXO frequency was modulated, the VCO would not track the higher audio frequencies (those beyond the closed loop bandwidth of the synthesizer). However, by modulating both the VCO and TCXO a flat audio response is achieved. Potentiometers RV101 and RV401 balance the modulating signals.

There are two 3.5V sources on the Exciter board; one is a reference for the modulation amplifier to the VCO, the other is for the modulation amplifier to the TCXO.

The reference voltage on U402B, pin 5 is also on buffer U407B, pin 5 to J401, pin 9 and RFIB connector J102, pin 9. The voltage leaves the RFIB on J101, pin 14 to J2, pin 27 on the backplane, to the bottom connectors via pin 7 and finally to the TPI on P100, pin 7.

With reference to the ground on the Exciter, the 3.5V reference stability is maintained by U126B/C/D on the TPI. The 3.5V DC passes through summing amplifier U129B and transmit modulation gate U118D to P100, pin 29 (Tx MOD). P100, pin 29 is connected to backplane connector J2, pin 8 and RFIB connector J101, pin 22 to J102, pin 13. The transmit modulation and 3.5V reference enter the Exciter on J401, pin 13 and are routed to U402B, pin 6. RV101 sets the TCXO modulation level. The modulation signal and the 3.5V DC are applied to U402A, pin 2.