# 1. Technical Description

The internal design of the MX920 is of a modular nature allowing for simple configuration and maintenance while ensuring minimal downtime.

## 1.1 Exciter Section

RF from the VCO is at a nominal level of +3 dBm is applied to the fractional-N synthesiser main divider input. This signal is compared with the reference oscillator frequency and the correction voltage from the synthesiser's charge pump output is filtered then amplified by an op amp. This correction voltage is fed back to the VCO to maintain loop lock as well as being fed to the Micro Controller. A lock detect signal is also fed to the Micro Controller. Frequency programming data for the exciter is sent to the synthesiser chip from the Micro Controller via a serial data line under the control of the Clock and Strobe lines.

A second RF output from the VCO also at +3 dBm is used as the main transmit RF amplifier signal source. The signal is further amplified by a variable gain wide band bipolar amplifier with 40 dB control range and power output of a nominal 300 mW. The drive power of this stage is used to set the output power to the main power amplifier under the control of the DC voltage from the Micro Controller board.

The VCO section and synthesiser circuits are the similar for the exciter and receiver sections. The power supply to the VCO uses an 8 volt regulator and active filter for maximum noise rejection. For standard modulation, transmit audio is fed to the conventional point of the VCO varactor.

### 1.1.1 General Radio Management

In addition to analogue signal processing circuitry the Micro Controller section accommodates a microprocessor IC2, a 16 kbyte EEPROM IC1, as well as I/O latches and other miscellaneous circuitry. The Micro Controller is responsible for ensuring that the radio acts as programmed by the user. It stores the user-entered parameters for each channel in EEPROM. This information includes RX and TX RF frequencies; RX and TX CTCSS frequencies as well as RF output power and operating mode. Virtually all logic control is done through the microprocessor.

The Micro Controller sends programming data to the synthesiser ICs in the Receiver and Exciter sections each time the channel is changed as well as on PTT. This information is communicated to the Receiver and Exciter sections by way of bussed data and clock lines and an individual module strobe. A lock detect signal from each section is read by the Micro Controller.

In addition to the synthesiser programming bus, an $I^2C$ bus goes to the main EEPROM and PA module EEPROMs.

IC29 is a flexible predictive or non-predictive, full duplex CTCSS / Selcall encoder / decoder, DCS decoder, which is under the control of the microprocessor.

### 1.1.2 TX Signal Processing

TX audio may be sourced from a number of different paths. These include Talk through audio, microphone and tone generators (ie Selcall, DTMF, DCS, CTCSS under micro controller control.

The microphone input is feed into a selectable compressor. It is then processed through a preemphasis, summing amp which also serves to combine the audio from the talk through path. Then pass through a HPF filter chain into a gain controlled latch circuit which is under control of microprocessor. The tone generator (Morse code / Selcall) signals from the microprocessor are applied to the input of the limiter amp. Following this the TX VF low pass filter. The standard filter has a 3.4 kHz cut off frequency. A second summing amplifier IC29B follows which combines the reference oscillator centre frequency adjustment and CTCSS level adjustment. The CTCSS signal is fixed to 500Hz deviation for Wide Band channels and 250Hz deviation for Narrow Band (10% of maximum deviation). This level is under microprocessor control (IC24C). The output of this final stage is fed to two microprocessor-controlled digipots, which serve to adjust the modulating signal level to the VCO and the reference oscillator. Adjustment of these levels is by way of the built-in radio configuration menu system using the Channel Edit screen.

The MX920 uses the technique of calibrating all Transmit Modulation level alignments in the Wide Band mode (25kHz channel spacing) for maximum accuracy. Gain setting resistor arrays switched under control by the microprocessor automatically scale the levels so as to set the correct modulation depth as required for Narrow Band channels.

### 1.1.3 RF Power Control

Forward power is controlled by the microprocessor through two mechanisms. Based on pre-programmed per channel adjustments the microprocessor sets the digital to analog converter output to a reference setting. IC28B serves as a comparator and, with the non-inverting input connected to the output of the digital to analog converter, is set up with a reference voltage. The detected actual PA forward power is fed to the inverting input of IC28B. The error voltage at the output of IC28B is fed to the exciter output power control circuit via SKB-4 and the action of the control loop is to set the RF power such that the actual detected volts equals the reference volts. The digipot setting is static for each channel unless the required forward power is changed.

The voltage to the top of the digipot is set up by the microprocessor through the Pulse Width Modulator output PWM1. On PTT the ON duty cycle of the PWM1 output is progressively increased and the filtered result of this forms a ramp to the top of the power control digipot. Once 100% duty cycle is reached full power is produced. This results in a fast but controlled RF power rise characteristic.

### 1.1.4 User Interface

All user interfaces to the MX920 except the TX RF connections is made by way of the Main Controller board.

- Output latch IC4 drives the six LED indicators on the front panel. An input port on IC2 serves to accept the programmed status of the 8-bit BCD channel select input from the front panel Push wheel switches.
- IC31 is a 3-Watt speaker amplifier, which drives the internal speaker.

- Microphone audio is into the front panel RJ45 connector. In addition to RX VF, Monitor control, Voltage output and PTT.
- IC13 provides CMOS to RS232 conversion for the serial port. This is also located on the Microphone RJ45 connector.
- The front panel adjustment Pots control Volume and Mute Squelch settings.

## 1.2 Power Amplifier Module

RF from the Exciter passes via a coaxial cable to the input of the PA Module and is first attenuated by a 50 ohm pad, which is used to provide a good 50 ohm source impedance for the first LDMOS driver amplifier. The RF is amplified to around 5 Watts at the driver output, and is band dependant. Note: this point does not have 50 ohm impedance and the drive power cannot be measured directly with a 50 ohm Wattmeter. The signal from the driver is then matched by a broadband network to drive the low input impedance associated with the final transmit LDMOS power amplifier transistor. The transistor's low Drain impedance is then also matched back to 50 ohms by a broadband matching network covering a very wide bandwidth. Prior to transmission, a low loss 13 element elliptical low pass filter, filters out the unwanted harmonics to less than –90 dBc.

A dual directional coupler consists of coupled microstrip transmission lines fabricated on the PCB artwork. The sampled RF energy is rectified to provide a proportional DC voltage output.

The PTT signal enables the amplifier circuit by providing bias to the transistors. A thermistor TS1, physically located on the PA heatsink monitors the heatsink’s temperature and is monitored by the Micro Controller.