

**SPECTRA  
MX800 RF TRANSCEIVER**



**USER MANUAL**

Manual Revision 1.2a August 1997

Applicable reference:

Micro Controller Board Rev C and on.  
MX800 Utility Software ver 1.0

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## Record Of Changes

Any changes to this manual are recorded on this list. Replacement pages may be issued to you by Spectra Engineering from time to time. If any updates are issued, you will also receive a replacement for this page.

Date	Manual Version	Chapter Changes	Pages Changed
May 1997	1.0	All - Initial Release	All
July 1997	1.1	MX800 Software	Software Only
August 1997	1.2	DIP switch settings MX800 Configuration Guide	Appendix C Appendix D

## SAFETY SUMMARY

Although there are no dangerous mains voltages present within the equipment, the following general safety precautions as would normally apply, should be observed during all phases of operation, service and repair of this equipment.

### AROUND THE EQUIPMENT.

To minimize any possible shock hazard from an external power supply or lightning strike, the chassis or equipment cabinet must be connected to an electrical ground. Provide adequate ventilation around the rear of the equipment.

### DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

### DO NOT ATTEMPT INTERNAL SERVICE WHILE TRANSMITTING.

Thermal or RF burns may result from touching certain components within the power amplifier module while transmitting or operating the transmitter.

### DO NOT SUBSTITUTE PARTS OR MODIFY THE EQUIPMENT.

Because of the danger of introducing additional hazards, do not install substitute or lower voltage parts to the equipment. Return to your authorized distributor.

### EXERCISE CAUTION AND CORRECT DISPOSAL OF RF POWER DEVICES.

Most RF power transistors and some RF power hybrids contain Beryllium Oxide. Although they are normally safe, if physically damaged toxic dust may be released. Consult your local authority for correct disposal thereof.

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## Introduction

The MX800 series of radio systems employ *state of the art* design and construction methods to deliver a range of high performance, ultra reliable radio devices. They are ideally suited for use in VHF or UHF two way voice radio systems, however the MX800 can perform any number of applications where the added advantage of linear frequency and phase response from DC to 5KHz can be utilized. The MX800, unlike conventional PLL radio systems, uses a two point modulation method synthesizer for extended low end VF transmit frequency response.

The flexibility of the MX800 series allows them to be configured for a wide range of applications, including;

- Standard or wideband voice, full duplex radio.
- Cellular or Trunking systems.
- POCSAG paging transmitter.
- Direct FSK modulation.
- APCO-25 compatible radio.
- 2 or 4 level FSK transmissions.
- Other paging formats.
- Radio modem base station such as RD-LAP or Mobitex.
- Cross band link or repeater.

Should ultra stability be required as for paging and APCO-25 applications, then the addition of an optional digitally synthesized DSP / DDS modulator will provide for stability to 0.1PPM.

## General Description

The MX800 series features a high degree of RFI and EMI screening throughout their design and construction. The receiver and exciter (low power transmitter) modules are contained in a solid machined aluminium enclosure, and for additional screening each interface pin is individually filtered. The PA module is contained in a special compact extrusion for minimum harmonic radiation. In addition to this the RF modules and the micro controller are also contained in the main screened 2RU case for low conducted and radiated emissions and minimal susceptibility to RFI and EMI.

The MX800 series consists of four main sub assemblies as outlined below: an Exciter Module, a Receiver Module, a Power Amplifier Module and a Micro Controller board. For further information on these sub assemblies, refer to the Technical Description section later in this manual.

## Exciter Module Description

The Exciter module features a modulation bandwidth to DC with an ultra wide RF bandwidth 20MHz to 1000MHz at an output power of 300mW. To change from one band to another, all that is required is to change the plug in VCO board, no other manual adjustment or change is required. Should a high stability reference be required, the RF modules can be fitted with connectors for an external reference oscillator input. On board memory stores calibration, personality information and program data. Alternatively, the exciter module can be set up as a conventional PLL should simplicity and minimum cost be required. The fractional N synthesizer provides ultra low spurs while still maintaining fast lock times even at 6.25KHz step size or less. An optional built turn around mixer (TRM) provides advanced diagnostics such as receiver sensitivity tests.

## Receiver Module Description

The Receiver module features the same advanced synthesizer and wide bandwidth as the exciter. Only the front end bandpass filter and VCO need to be changed in order to support different frequency bands, resulting in significant flexibility and end-user cost savings. The custom built front end bandpass filter has a wide no-adjust bandwidth equal to the band allocation. The receiver has extremely high sensitivity while maintaining excellent intermodulation immunity and adjacent channel rejection. A double first IF provides excellent rejection to common known spurious responses. High blocking of over 120dB typical ensures that strong interfering signals do not desensitize the receiver when receiving weak signals.

## Power Amplifier Module Description

The PA is very compact and efficient for high reliability and low cost. The heatsink has minimal temperature rise even under continuous operation, this also ensures the best MTBF obtainable for a practical design. A low loss 13 element elliptical low pass filter ensures that any harmonics remain below -100dBc.

## Key Features and Advantages

- Exceptional system performance.
- Modular internal construction.
- Software or hardware configurable.
- 50 Watt continuous transmitter.
- Programming via RS232.
- 256 channel capacity.
- Optional CTCSS.
- Optional on board modems.
- Paging capability.
- VF filters and processing can be bypassed.
- Fast mute.
- 20mS Rx and Tx. 4mS selectable.
- Front panel display.
- Digital squelch compatible.
- Wide band Rx and Tx.
- Isolated PTT input.
- Digitally controlled and corrected Tx deviation.
- Programmable Tx power.
- Direct FSK or paging compatible.
- Optional DSP/DDS modulator.
- VSWR and Temp protection.
- Compact 2RU case.
- 13.8 Volt operation.
- Available in continuous coverage from 66-88MHz, 135-520MHz and 805-960MHz.
- Surface mount technology used throughout.
- Rear analog and digital interfaces.

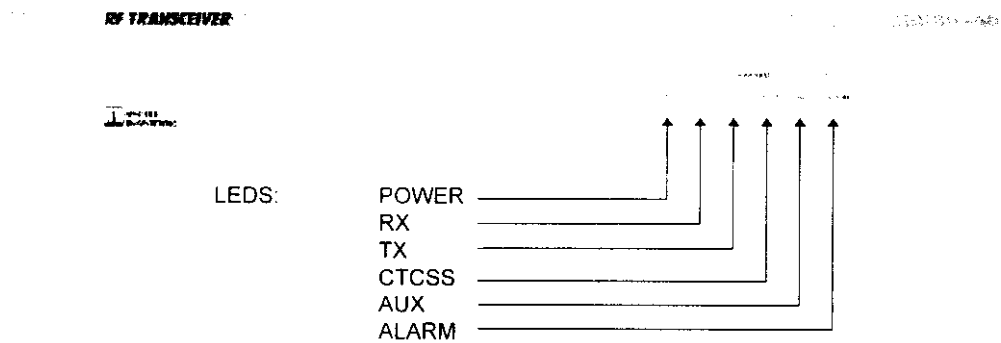
Other options and variations available, please consult Spectra Engineering for further details.

## Indicators and Connectors

The MX800 series can be supplied with custom front panels. The standard and OEM versions are shown below. The following tables explain the functions of the front panel LEDs. Each LED indicates the status of the MX800 base station in real time.

### Standard Version front panel

LED	FUNCTION
POWER	Indicates the power supply voltage is within software selectable limits.
RX	A signal is being received by the receiver or the receivers squelch is open.
TX	The transmitter is transmitting RF power.
CTCSS	A valid Continuous Tone Coded Squelch Signal has been detected.
AUX	Aux function is selected or the PLL is unlocked.
ALARM	A general alarm condition exists such as under / over voltage or over temperature.



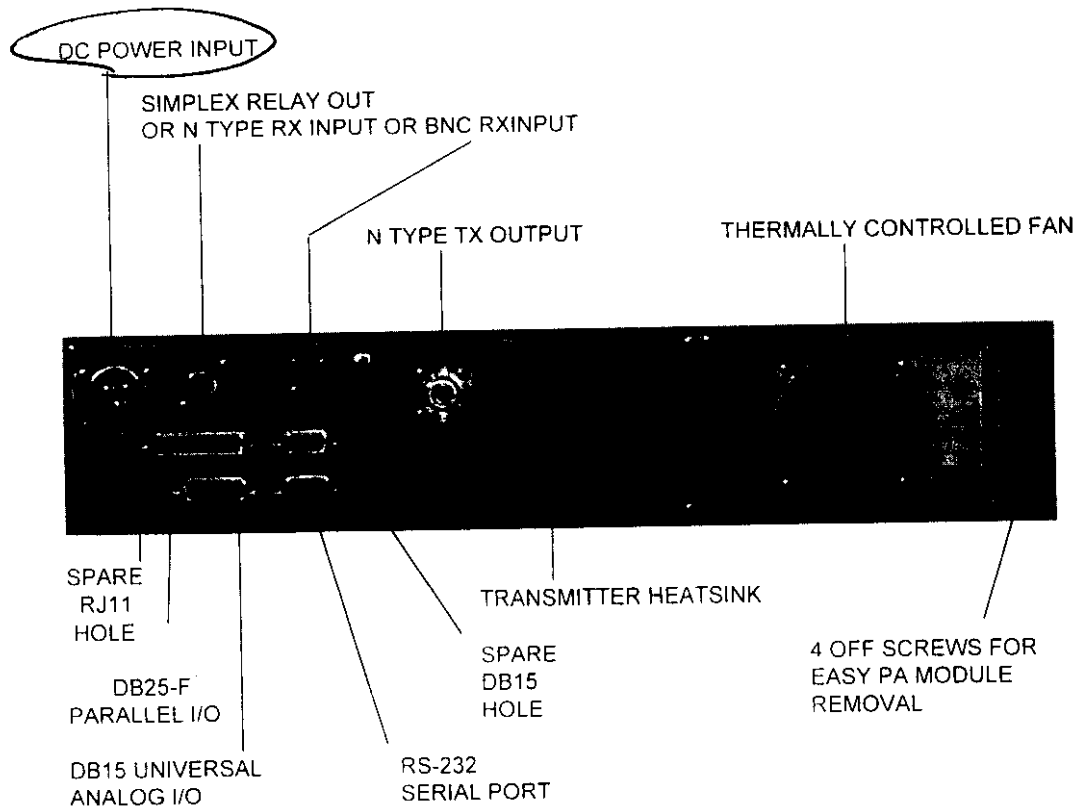
### OEM Version front panel

LED	FUNCTION
POWER	Indicates the power supply voltage is within software selectable limits.
RX	A signal is being received by the receiver or the receivers squelch is open.
TX	The transmitter is transmitting RF power.
LOW V	Indicates the power supply voltage is below the software selectable limit.
LOCK	The RX PLL is locked correctly or the TX is keyed and the PLL is in lock.
HI TEMP	Indicates the power amplifier's temperature has exceeded the software selectable limit.

## Rear Panel Connectors

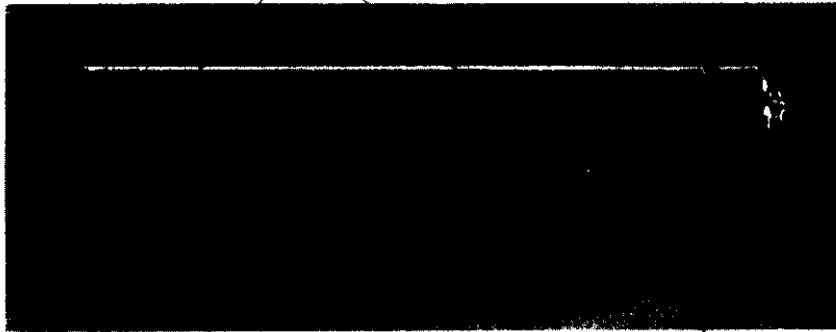
CONNECTOR	DESCRIPTION
DC POWER INPUT	13.8 Volt DC power input. Also +28 Volt input on spare pin.
SIMPLEX RELAY OUT OR N TYPE RX INPUT	Location for internal simplex relay. The antenna for RX / TX connects to this point. Else a N-Type connector can be used for the input to the receiver for full duplex operation.
BNC RX INPUT	Standard BNC connector for the input to the receiver for full duplex operation.
N TYPE TX OUTPUT	The RF power output from the transmitter for full duplex operation.
SPARE RJ11	Provision for internal expansion.
DB25-F PARALLEL I/O	Provides two 8 bit input ports, where one is used as the parallel BCD channel select. Also one spare 8 bit input port.
DB15 UNIVERSAL ANALOG I/O	Provides the necessary analog receiver and transmitter interface for system expansion.
RS-232 SERIAL PORT	9600 Baud serial port for frequency programming, channel selection and alarm and status monitoring.
SPARE DB15	Provision for internal expansion.

## Rear view MX800



## Side view MX800

MOUNTING HOLES FOR SLIDE-OUT RAILS



THE HEATSINK AIRFLOW EXITS SIDEWAYS SO ANY NUMBER OF MX800 CAN BE STACKED IN A RACK ONE ABOVE THE OTHER

## Installation

**WARNING:** Ensure that all safety precautions are observed when working with electrical and electronic equipment. Please contact Spectra Engineering if you are in any doubt about the suitability of your test environment.

MX800 series radio systems are securely packed for transport in polystyrene foam peanuts, within a pasteboard container. Before unpacking the MX800 radio, please inspect the packaging for signs of damage and report any damage to your MX800 distributor.

Upon unpacking of the MX800 radio, please ensure that all items shipped were received, report any missing items to your MX800 distributor. All ports on the rear of the radio should be carefully examined to ensure that packaging has not become wedged inside them. It is very important to examine the fan as operation of the radio will be effected if any packaging causes the fan to stop working.

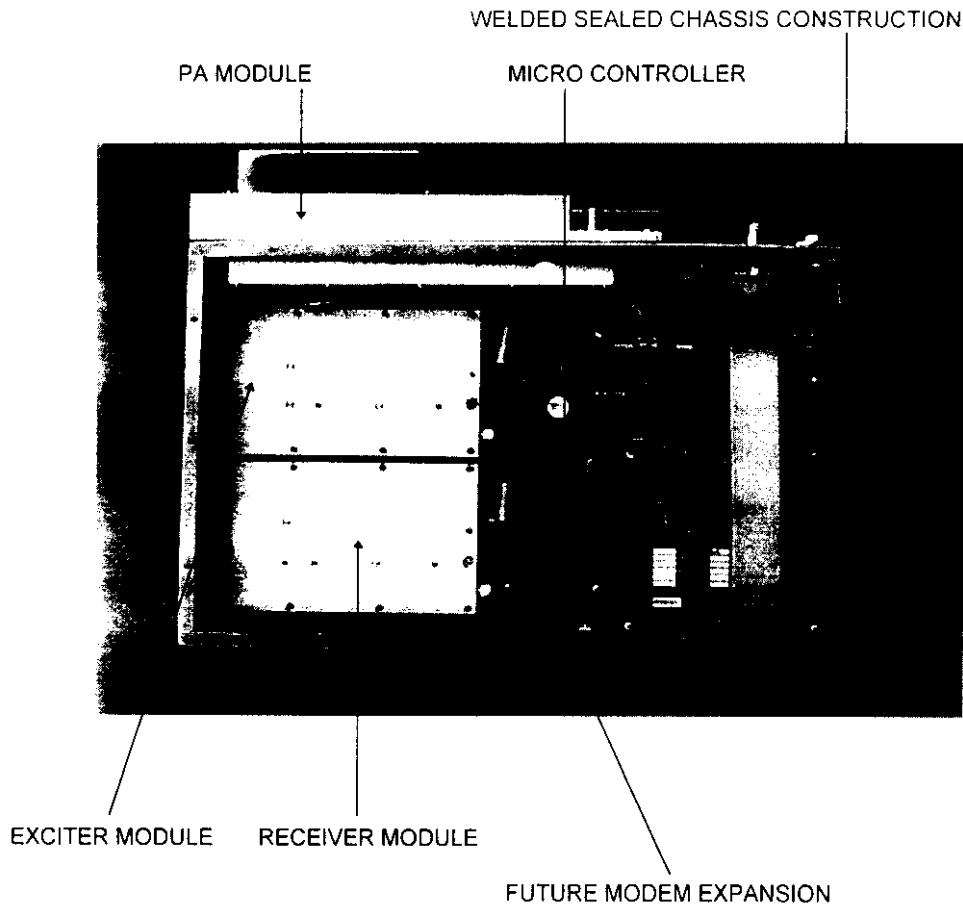
If you intend to install the radio in an equipment rack, consult the installation manual for your system. Spectra Engineering recommends that the radio is secured into the rack system using four screws through the mounting holes in the front panel, near the handles.

If the radio is to be used in a stand alone configuration, ensure that it is in a secure, dry location with sufficient air space around it to allow for adequate ventilation.

## Technical Description

### Internal Connections

The internal design of the MX800 is of a modular nature, allowing for simple configuration and maintenance while ensuring minimal downtime. For reference purposes, an image of a typical MX800 system is shown below.



## Exciter Module Technical Description

RF from the VCO, at a nominal level of +3dBm, is applied to the fractional-N synthesizer IC main divider input, a second, separate RF output of the same level from the VCO is used as the main transmit RF amplifier signal source. The main signal is first buffered by a very high isolation circuit consisting of a 10dB pad and a MMIC amplifier. The signal is further amplified by a variable gain wide band amplifier with 40dB control range and power output of 300mW. The drive power of this stage, is used to set the output power of the main power amplifier. The synthesizer's charge pump output is filtered then amplified by the non inverting low noise op amp. The op amp uses a 25 volt power supply so as to provide a wide tuning range voltage to the frequency control varicaps located on the VCO board.

The VCO boards and synthesizer circuits are the same for the exciter and receiver modules. The VCO consists of a 10mm ceramic coaxial resonator with common base oscillator for low phase noise for bands 805-960 MHz. Frequencies below 520 MHz use an LC tank circuit. The power supply to the VCO consists of a its own 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. For 2 point modulation, audio is also fed to the voltage control pin of the VC-TXCO, this in effect cancels out the PLL error that would otherwise have occurred for low audio frequencies, hence resulting in a flat VF response.

## Receiver Module Technical Description

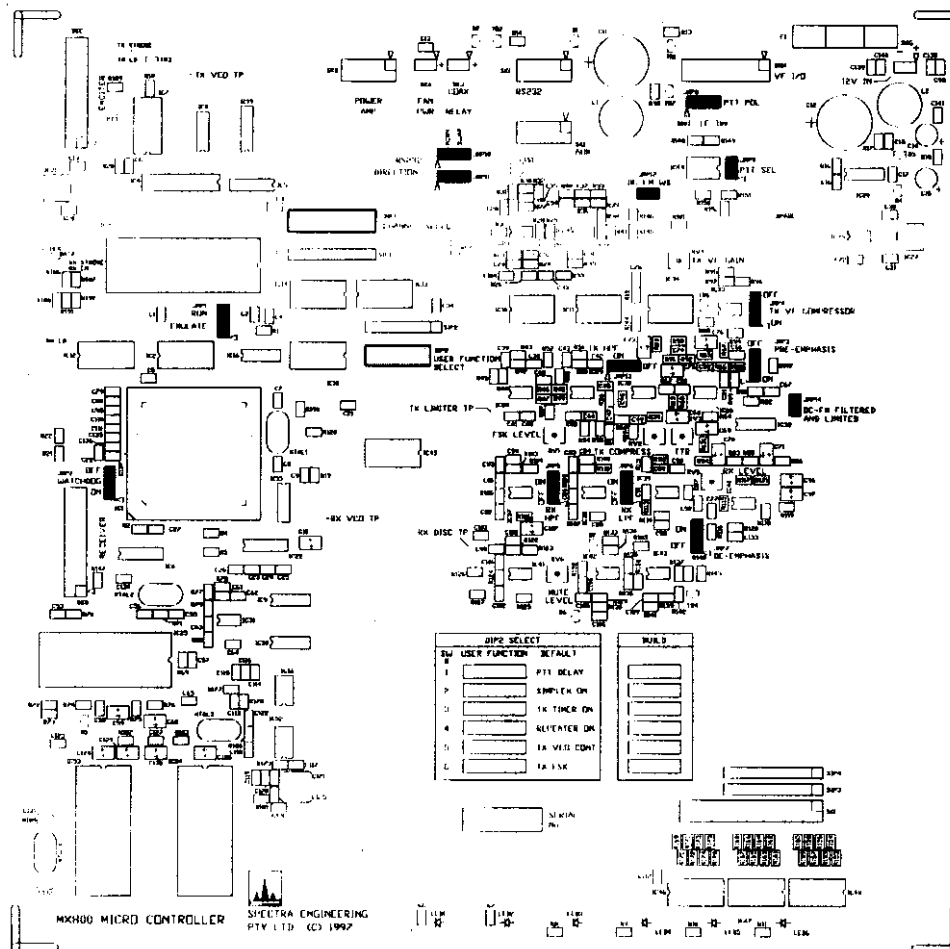
The receive signal from the antenna enters a 3 section Bandpass filter which provides the initial filtering for the front end amplifier. The front end amplifier is a broad band high performance MMIC with a gain of 20dB, NF of 4dB and 3rd OIP of +36dB. This is then followed by the second 3 section BPF, then a high level double balanced mixer. RF from the VCO is buffered and amplified to +17dBm and injected in the high level mixer which down converts the signal to the IF frequency of 90 MHz. The IF signal of 90 MHz from the mixer is terminated by a bi-directional constant impedance diplexer network and is then amplified by a bipolar amplifier with a gain of 15dB and 3rd OIP of +35dB. This provides a high degree of intermodulation rejection for the receiver. This stage is followed by a 4 pole 90 MHz crystal filter with its associated matching networks. The signal is further amplified and filtered by a transistor and its associated 2 pole crystal filter before being fed into the main IF demodulator chip with a second IF frequency of 455 KHz. The resulting audio is passed out to the micro controller board.

## PA Module Technical Description

RF from the exciter is first attenuated by a 50 ohm pad which is used to provide a good 50 ohm source impedance for the high power hybrid amplifier. The RF is amplified to between 5 and 13 watts at its 50 ohm output. The signal from the hybrid is then matched by a broad band network to drive the low input impedance associated with the final transmit power amplifier transistor. The transistors low collector impedance is then also matched back to 50 ohms with a broad band matching network. Several trimmer capacitors enable adjustment of the power amplifier over a wide bandwidth so as to maintain good conversion efficiency.

The 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. Prior to transmission a low loss 13 element elliptical low pass filter, filters out the unwanted harmonics to less than -100dBc.

The view below is an image of the micro controller layout and the position of the jumpers and DIP switches (highlighted) which are used for setting the general configuration of the audio filters, PTT functions and other various facilities.



**NOTE: Not all components shown are fitted.**

## Description of Micro Controller Jumper functions

<b>JMP #</b>	<b>FUNCTION / DESCRIPTION</b>
--------------	-------------------------------

<b>JMP 1</b>	Selects either default RUN or EMULATE mode for the micro processor.
<b>JMP 2</b>	Enables the WATCHDOG auto reset function in the micro processor.
<b>JMP 3</b>	Enables or disables the PRE-EMPHASIS for the Tx audio.
<b>JMP 4</b>	Enables or disables the COMPRESSOR for the Tx audio.
<b>JMP 5</b>	Enables or disables the HIGH PASS FILTER for the Rx audio.
<b>JMP 6</b>	Enables or disables the LOW PASS FILTER for the Rx audio.
<b>JMP 7</b>	Enables or disables the DE-EMPHASIS processing for the Rx audio.
<b>JMP 8</b>	Selects a common earth or floating PTT input. Also see Appendix B.
<b>JMP 9</b>	Selects the PTT mode. Also see Appendix B.
<b>JMP 10</b>	Controls the direction of the RS-232 Tx and Rx data. Also see the next section and Appendix B.
<b>JMP 11</b>	Controls the direction of the RS-232 Tx and Rx data. Also see the next section and Appendix B.
<b>JMP 12</b>	Enables a direct connection to the Tx modulation. Not normally used. Also see Appendix B.
<b>JMP 13</b>	Enables or disables the HIGH PASS FILTER for the Tx audio.
<b>JMP 14</b>	Enables a direct connection to the Tx modulation via the limiter and post LPF. Also see Appendix B.

## Testing

The following equipment is required to test MX800 series radios:

- A Radio communications test set with 600  $\Omega$  interfaces.
- A digital multimeter.
- An oscilloscope.
- 13.8V Power Supply.
- A PC compatible personal computer with at least 8Mb of RAM, a serial port and the "MX800 Base Station Utility" software installed.
- A suitable cable to connect the serial port of the PC to the MX800 radio's RS-232 port. The details of this cable can be found in Appendix B.
- A suitable power lead as supplied with the radio is being tested.
- Suitable low loss RF cables and connectors.

**WARNING:** Attempting to operate the transmitter without an appropriate load connected to the RF output may cause physical damage to the unit and void the warranty. Please contact Spectra Engineering if you are in any doubt about the suitability of your test environment.

## Connecting a computer to the MX800 radio.

The standard cable used to connect the computer to the MX800 is a serial "Lap-Link" type cable. This usually consists of a lead with a DB9 and DB25 female connector at each end. The Rx and Tx data signals are cross connected in "Lap-Link" type cables. There are two jumper links on the Micro Controller circuit board inside the MX800 designated JMP10 and JMP11, their default position is pin 2&3 or "SWAP". This indicates that a lead which swaps Rx and Tx data is in use.

Other special serial leads can also be used. In order to allow for more combinations you can set JMP10 and JMP11 to position 1&2 or "NORM" which has the effect of swapping over pins 2 and 3 on the DB9 rear connector.

## Test Setup

All connections are made at the rear of the MX800.

Connect the Transmitter RF output located on the heatsink module to the dummy load / Tx test input of the Radio Communications Test Set using a short length of low loss RG 213 or equivalent coaxial cable.

Connect the Receiver RF input to the Signal Generator output of Radio Communications Test Set using moderate to low loss coaxial cable

Connect all VF interfaces' and control lines to the appropriate points.

Connect the MX800 Radio to a suitable 13.8 Volt DC power supply while observing the correct polarity.

## Test Procedure

Refer to Calibration Procedure.

## MX800 Base Station Utility

### Initial Setup And Description

#### Main Display Tool Bar Description

The "Channel Info" button is used to view and setup the frequency information in the MX800.

The "Analyse" button reads the internal status of the MX800 and displays as such.

The "Update" button is only used when SETUP - DYNAMIC is selected. Pressing "Update" sends the dynamic settings to the MX800 for quick initial testing. The values are not saved in the MX800. It is also used to setup the default values as used in the channel programming.

The other buttons duplicate "Save", "Open File", "Send Data to Radio" and "Load Data from Radio" as seen on the Channel Info screen respectively.

### Initial Settings

In order to read or send data to the MX800 a file must first be created or opened.

### Initial Static Settings

Go to SETUP STATIC and set the appropriate values and conditions for the MX800. Press "SEND" to send and store the values inside the MX800. Note that reference, IF frequencies and injection are not stored in the MX800, so this must reflect the actual physical conditions of the MX800. The standard reference oscillator is 14.4MHz. The Standard IF is 90MHz, with high side injection Bands A to I and low side J to X. The PLL correction factor value is usually around 120. The fan on temperature is normally set to 40C with the over temperature cutout at 70C.

### Channel Programming and Description

In the Channel Info screen click on the channel you wish to setup. You can view all of the settings and calibration data, however you will need to enter the password by clicking the "Advanced" button to proceed. This level of protection is provided to advise that changes may allow the transmitter to potentially cause interference to vital radio communications services. See also the QUICK FREQUENCY PROGRAMMING and FULL CALIBRATION sections.

## QUICK FREQUENCY PROGRAMMING

( If a calibrate has already been performed)

In the channel information screen, click the channel number you wish to change or create. Enter into the "Advanced" mode with the correct password. Enter the frequencies of the channel. Inject an audio signal with sufficient level (~0dBm) to ensure compressor operation and check the deviation is 3KHz for 25KHz channel spacing or 1.5KHz for 12.5KHz spacing. Adjust the VCO deviation for the correct level. Most of the other settings will not change. If in doubt see the FULL CALIBRATION section.

## FULL CALIBRATION

**(TX MODULATION) Suggested Method**

Recommended Full Calibration Procedure with DC-FM installed. The alignment may be carried out in the SETUP DYNAMIC for a quicker result. Calibration is performed on the center RF frequency.

1. Set the Reference Level to 0 and the Reference Bias to 127.
2. On the MX800 Micro controller Board set Pre-emphasis, Tx HPF and the Tx VF Compressor to OFF. Turn the Tx Compress Level RV2 fully clockwise to maximum. This will allow the hard limiter to operate.
3. Inject a 1KHz audio signal into the Tx VF input at a level of +10dBm. Check with an oscilloscope that the audio signal is clipped at the Tx Limiter Test Point.
4. Set the VCO Level to achieve 4.8KHz deviation (clipped waveform) in the case of 25KHz channel spacing and 2.3KHz deviation in the case of 12.5KHz channel spacing. If CTCSS is used then subtract further the nominal CTCSS system deviation level.
5. Reduce the level from the audio oscillator to obtain a sinewave modulation, now vary the modulation frequency around 50 to 500Hz and adjust the Bin Accel Factor for an approximately flat response.  
Caution: Do not enter too low a value or the lock time and stability will be affected.  
Return the audio level to +10dBm.
6. Set the modulation frequency to about 300Hz. Observe the demodulated clipped sinewave with drooping positive and negative deviation peaks. Now increase the "Ref Level" and the degree of drooping will reduce. Adjust so that flat top is observed on the demodulation waveform. Check that if you vary the modulation frequency across a range of 50Hz to 1KHz the frequency response is flat. The peak deviation should still be the same as in step 4, if not repeat steps 4 and 6.  
Note: The modulation flatness will rise around 2KHz if the MX800 is fitted with Butterworth or Chebychev type filters for the main limiter post LPF as used in the EIA-603 Build. It is due to the filters group delay distortion. For a flatter response ensure the standard Bessel filter is fitted.

7. Set the transmitter carrier center frequency by adjusting the "Ref Bias" Level if necessary. Check again step 6 as there is some interaction from the reference oscillator due to non-linearity. Repeat as necessary.
8. Save as defaults.
9. Return the jumpers as previous in step 2. Adjust the Tx Compress Level RV2 for the standard system deviation level. Usually 3KHz for 25KHz channel spacing and 1.5KHz for 12.5KHz spacing.
10. Set the VF level to the standard input level (-10dBm) and adjust the compress Tx VF Gain to just compress.
11. Go to the Channel Info screen and click on the channel number to be allocated to the calibration results. Click on Get Defaults, then OK.
12. Go to the next channel and load defaults. Key in the appropriate RF frequencies and set the VCO Level for the same deviation as in step 9. Repeat this step for all the channels required. Note that a small error will result in the calibration of the "Ref Level" as in step 6 if the next channel frequency varies greatly from the original cal frequency. Recalibrate the "Ref Level" if necessary.

**Caution:** Due the high degree of adjustment available in the MX800, check the PLL stability by monitoring the PLL tune voltage with a CRO at the onset of PTT for minimal ringing.

## Description of Program Functions

### Synthesizer Control

The MX800 Base Station has the facility for precise software control of the PLL characteristics. This provides user with additional flexibility and capability for specialized or precise setting. The following program functions allow for control of the fractional-N synthesizer and are described as such:

**PLL Correction Factor:** Controls the relative amount of charge current into the PLL charge - pump circuit. The value for the PLL Correction Factor is loaded into the receiver and exciter synthesizer during normal operation. It is primarily used to control the dynamic PLL settling characteristics. A value of 0 will provide a minimum current and hence a slow and under damped loop response. A value of 255 will provide the maximum current and hence a fast and overdamped loop response.

**Bin Accel Main:** Same as PLL Correction Factor except that the value for the Bin Accel Main is only loaded into the exciter synthesizer during the transmitter modulation period. It is primarily used to control the static PLL characteristics. This will allow adjustment for a maximally flat modulation response near the cutoff frequency of the PLL. A value of 0 will provide a minimum current and hence an under damped response. A value of 255 will provide the maximum current and hence an overdamped response.

**Modulo:** A modulo value of 8, sets the synthesizer comparison frequency to 8 times that of the Channel Spacing (synthesizer step size). A value of 5 is 5 times respectively.

**Channel Spacing:** May also be referred to as the synthesizer step. As a rule the oscillator frequency must be integer divisible by the modulo value and then the step size. The step size is usually set to half that of the channel spacing.

**Accel Proportion:** Controls the degree of speedup at the onset of PTT.

**Accel Integral:** Controls the multiplication factor of the Accel Proportion.

For further information and reading, you may refer to the Philips Semiconductor Data Book for the SA7025DK chip.

## Modulation Control

DC-FM uses two point modulation and its parameters can be set by the following:

**VCO Deviation:** The digital pot value sets the modulation level fed to the VCO's modulation input. A value of 0 sets the minimum deviation level. A value of 255 sets the maximum deviation level.

**Reference Bias:** The digital pot value sets the center carrier frequency of the transmitter frequency. A value of 0 sets the highest carrier frequency. A value of 255 sets the lowest carrier frequency. A value around 128 is normally used. If the value is too high or too low this may result in unsymmetrical modulation distortion due to the limited range of the master reference oscillator.

**Reference Level:** The digital pot value sets the modulation level fed to the master reference oscillator. A value of 0 sets the minimum deviation level. A value of 255 sets the maximum deviation level. It primarily is used to set the modulation balance at low frequencies.

## Transmit RF Power Output

**Transmit Power:** The digital pot value sets the RF drive level to the power amplifier. A value of 0 sets the transmitter power to minimum. A value of 255 sets the transmitter power to maximum.

## CTCSS Control

**Tx Subtone:** Enters directly the frequency of the transmitter's modulation encoder.

**Rx Subtone:** Enters directly the frequency for the receiver's decoder to operate.

**Tx Subtone Level:** This value controls the level of the transmitter's modulation encoder. Steps are 0.85dB.

## Channel selection

Three methods are available for channel selection.

**Software Channel Select via Utility Program:** First ensure that channel 0 is selected on the DIP switch DIP1 located on the Micro Controller Board (all 8 switches in the off position). Enter the channel number in the Software Select Channel window on the Channel Info screen and press Select.

**Software Channel Select via Serial Command:** First ensure that channel 0 is selected on the DIP switch DIP1 located on the Micro Controller Board (all 8 switches in the off position). Send the string "chansXXX" where XXX = a 3 digit number for the channel number. eg To select channel 5 send the string "chans005". Baud rate is 9600 BPS.

**Hardware Channel Select:** Select the fixed channel for the MX800 by using the DIP switch DIP1 located on the Micro Controller Board. Channel 1 to 255 is available in binary selection. Switch position 1 is channel 1, position 2 is channel 2, position 3 is channel 4, position 4 is channel 8, position 5 is channel 16, position 6 is channel 32, position 7 is channel 64, position 8 is channel 128. For further details of all possible channels see APPENDIX C.

## Troubleshooting

The most common causes of problems are listed below.

Incorrect parameters set in MX800 Utility Program such as

1. Wrong Reference frequency oscillator value.
2. PLL correction factor or Bin Accel value too low.
3. Accel values extreme.
4. Channel spacing value not correct.
5. Frequency value is not a multiple of the channel spacing / step size.

Other problems may include Jumpers or DIP switches in wrong positions

## Glossary

3RD OIP	Third Order Intercept Point
4LFSK	4 Level Frequency Shift Keying
APCO-25	Associated Public-Safety Communications Officers, Inc. Project 25
AUX	Auxiliary
BPF	Band Pass Filter
BW	Bandwidth
CMOS	Complementary Metal Oxide Silicon
CRO	Cathode Ray Oscilloscope
CTCSS	Continuous Tone Coded Squelch System
DC	Direct Current
DIP	Dual Inline Package
DDS	Direct Digital Synthesis
DSP	Digital Signal Processor
EMI	Electro Magnetic Interference
FSK	Frequency Shift Keying
HPF	High Pass Filter
IC	Integrated Circuit
IF	Intermediate Frequency
I/O	Input / Output
JMP	Jumper
LC tank circuit	Resonant circuit consisting of an Inductor and Capacitor network
LED	Light Emitting Diode
LPF	Low Pass Filter
MMIC	Microwave Monolithic Intergrated Circuit
Mobitex	Radio messaging system
MTBF	Mean Time Between Failure
NF	Noise Figure
PA	Power Amplifier
Pad	Circuit board land
PCB	Printed Circuit Board
PLL	Phase Locked Loop

PPM (ppm)	Parts Per Million
PTT	Push To Talk
POCSAG	Post Office Code Standardization Advisory Group
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RU	Rack Unit
Rx	Receiver
Simplex	Single operation of either Transmitter or Receiver
S/N	Signal to Noise Ratio
Squelch	Muted audio signal
SW	Switch
TEMP	Temperature
TRM	Turn Around Mixer
Tx	Transmitter
UHF	Ultra High Frequency
VCO	Voltage Controlled Oscillator
VC-TXCO	Voltage Controlled Temperature Compensated Crystal Oscillator
VF	Voice Frequency
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio

## Appendix A Specifications

### Minimum Performance Specification

Minimum performance to exceed the following for 66MHz to 960MHz\*:

AS4295-1995  
 ETS 300 086 Jan 1991  
 FCC Part 90  
 TIA/EIA-603  
 BAPT 225 ZV 1/2098 (German Softkeying)  
 CEPT T/R 24-01 E Sept 1988  
 EC Marking, EC EMC Directive 89/336/EEC  
 ETS 300 113  
 MIL-STD-810E  
 RFS32  
 TIA/EIA-603  
 TSB102, CAAB (APCO 25 C4FM) Class A

\*Conforms but may not be approved.

Consult Spectra Engineering regarding current type approvals.

### General Specifications

MX800 Rack Size:	2RU Case, 330mm deep inc fan.
MX800 Overall Physical Size	89mm high, 360mm deep, 483mm wide
Supply Voltage:	13.8V +/- 20%.
Power Consumption:	- 600 mA receive, typical 440 mA. - 11A for 50W Tx RF.
Operating Temperature:	-10 to +60 C. -30 to +60 C option.
Individual Module Dimensions:	Rx & Tx W=100, L=180, H = 30mm. PA W=78, L=300, H = 60mm.
Standard LED indicators:	Power, Rx, Tx, CTCSS, Aux, Alarm.
Frequency Range:	Coverage 66-960 MHz.
Synthesis Method:	Non mixing PLL. Fractional N synthesizer.
Modulation:	Direct FM, +/- 5 KHz +/-2.5 KHz narrow band.
Channel Spacing:	30 KHz, 25 KHz or 12.5 KHz.
Synthesizer Step Size:	30, 25, 12.5, 7.5 or 6.25KHz.
Channels:	256 Software or switch selectable 1-99 BCD parallel selection.

Frequency Range: Coverage 66-960 MHz.

Other frequencies or band allocations available.  
Contact Spectra Engineering for details.

Band A 66-80 MHz.  
Band B 74-88 MHz.  
Band C 135-160 MHz.  
Band D 155-180 MHz.  
Band E 175-200 MHz.  
Band F 195-225 MHz. ?  
Band G 220-250 MHz. ✓  
Band H 245-275 MHz.  
Band I 270-300 MHz.  
Band J 295-325 MHz.  
Band K 320-350 MHz.  
Band L 345-375 MHz.  
Band M 370-400 MHz.  
Band N 395-430 MHz.  
Band O 425-460 MHz.  
Band P 455-490 MHz.  
Band Q 485-520 MHz.  
Band R 805-825 MHz.  
Band S 824-849 MHz.  
Band T 850-870 MHz.  
Band U 872-905 MHz.  
Band V 890-915 MHz.  
Band W 917-950 MHz.  
Band X 925-960 MHz.

## Transmitter Module Specifications

RF Power Output:	5W to 50W (66-520 MHz). 5W to 35W. 50W optional for 13.8V/28V rail(800-960 MHz). 100W on special request.
Frequency Stability:	2.5PPM, 1.5PPM or 1.0PPM.
Audio Response:	Flat within +/- 0.5dB across BW. Bessel LPF for data or Chebychev LPF
Audio Bandwidth:	DC(J-X Band) to 3400Hz base band (-0.5dB) 300Hz to 3000Hz for EIA-603 300Hz to 3400Hz nominal.
Modulation Distortion:	Less than 2% C-weighted.
S/N Ratio:	Better than 50dB, wide band. Better than 44dB, narrow Band.
Spurii:	Better than -90dBc.
RF Switching Bandwidth:	Same as band allocation.
RF Switching Bandwidth PA:	10MHz nominal, full band useable.
Duty Cycle:	100% for 50W RF output with Thermal controlled fan.
RF Rise Time:	4mS with continuous VCO selected (Controlled RF envelope).

## Receiver Module Specifications

Sensitivity:	Better than -117dBm for 12dB ( 25 KHz spacing ), C-weighted, De-emphasis. Typical -120dBm
Selectivity 66-520MHz (Option):	More than 80 dB for 25 KHz adj channel, more than 70 dB for 12.5 KHz adj channel, for switching BW 10MHz minimum.
Selectivity 66-520MHz:	More than 75 dB for 25 KHz adj channel, more than 65 dB for 12.5 KHz adj channel, for switching BW same as band allocation.
Selectivity 805-960MHz:	More than 70 dB for 25 KHz adj channel more than 65 dB for 12.5 KHz adj channel for switching BW same as band allocation.
Spurious Resp:	Better than 90dB.
Intermodulation:	Better than 80dB.
Blocking:	Better than 100dB at +/- 1MHz point.
Distortion:	Less than 2%.
S/N Ratio:	Better than 50dB C-weighted, wide band. Better than 44dB C-weighted, narrow band .
RF Switching Bandwidth:	10MHz minimum or equal to band allocation.
Receiver Front End BW:	Equal to band allocation, no retuning.
Audio Bandwidth:	DC to 3400Hz (-0.5dB)
Squelch Opening Time:	20mS.
Squelch Closing Time:	100mS.
Conducted Spurious:	Less than -57dBm, typ -90dBm.

## Ancillaries

Tx Timer:	2 minutes, on/off selectable.
VF Level to Line:	+6 to -15dBm, 600 ohms unbalanced or differential.
VF Level from Line:	+6 to -15dBm, 600 ohms unbalanced
Pre-Emphasis Accuracy:	Within +/-0.5dB of 6dB per octave curve.
De-Emphasis Accuracy:	Within +/-0.5dB of 6dB per octave curve.
VF Compressor Range:	-30dB for line input.
Control Outputs:	1K ohm 5V source/sink available.
Alarm Output:	Open collector.
PTT Input:	Logic or Opto-isolated +/- 5 to 48V.
Channel Select:	8 way Dip switch or RS232 or BCD
Repeater Tail Timer:	2 seconds nominal.

## Appendix B Interface Connections

### MX800 Rear Chassis Connector Description

#### Universal DB15 Analog I/O

Pin Number And Description:

Universal Analog I/O DB15 Female Rear Connector			Universal Analog I/O DB15 Male Rear Connector			Internal Circuit Board Header SKH Connector			Description
Pin	Pin	Pin	Pin	Pin	Pin	Pin	Pin	Pin	
8	1	1							<b>EARTH.</b> Use this Earth for general connection and PTT return. For Analog Earth and Audio common use the ANALOG EARTH pin.
15	9	2							<b>RECEIVER AUDIO 600Ω.</b> Normal receiver audio output from op-amp. Nominal line level is set to -10dBm. Common return to analog Earth or differential audio output pin.
7	2	3							<b>RECEIVER AUDIO 5Ω.</b> Low impedance differential audio output from op-amp.
14	10	4							<b>RX MUTE / SQUELCH MONITOR.</b> The mute status may be monitored by reading this voltage. 5 volt logic high = signal received or the mute is open. Output impedance = 100KΩ. Connect to high input impedance (>1MΩ).
6	3	5							<b>O/C ALARM OUTPUT.</b> Open collector output sinks current to earth when an alarm condition occurs. Same function as front panel Alarm LED. An alarm is generated if the Power Amplifier is over temperature or if the supply voltage exceeds the defined limits. The trip points are selectable via the utility program.
13	11	6							<b>TX DC-FM INPUT.</b> Wide band audio or data may be connected to this point. In order to conform to transmitter bandwidth emissions limits, this input is hard limited to the nominal deviation and Bessel filtered -3dB @ 3400Hz for minimum group delay. Input impedance is 100KΩ. If this input is not used then jumper # JMP14 on the Micro Controller board should be removed to avoid any pickup of stray signals, or alternatively do not connect any wires to this pin. Also avoid the use of ribbon cables longer than 30-50cm as this may also result in excess coupling or crosstalk.
5	4	7							<b>TX REFLECTED POWER.</b> The voltage from the reflected power directional coupler in the Power Amplifier goes directly to this pin. In a correctly terminated load the voltage should be less than 200mV. Depending on the degree of mismatch at the load, the voltage will rise to approx 3-4 volts for 50 Watts forward power. The internal reflected power control circuit also monitors this point, such that when the reflected power voltage exceeds half that of the forward power voltage the forward power is then reduced to about 25% of full power. Full forward power is returned when the reflected power drops below the trip point mentioned. The output impedance is about 5KΩ.
12	12	8							<b>TX PTT IN.</b> The standard PTT input is normally active low and may be driven from standard logic outputs or open collector. JMP9 should be in and JMP8 in position 1-2. To change polarity or voltage input also see OPTO PTT IN. Removing JMP9 will

			input the PTT via the opto coupler.
4	5	9	<b>RX DISCRIMINATOR.</b> The receiver discriminator audio output is buffered, unfiltered and DC coupled to this point. Output impedance is low.
11	13	10	<b>TX OPTO PTT IN.</b> This input is only used if a floating or opto input PTT is required. JMP9 <b>MUST</b> be removed. Positive or negative keying voltage can be applied to the input due to full wave rectifier and opto circuit. For a fully floating differential input voltage (+/-5 to +/-48 VDC) set jumper JMP8 in position 1-2. Putting JMP8 in position 2-3 will connect this point to earth.
3	6	11	<b>TX FORWARD POWER.</b> The voltage from the forward power directional coupler in the Power Amplifier goes directly to this pin. In a correctly terminated load the voltage should be about 3-4 Volts for 50 Watts. The output impedance is about 5K $\Omega$ . The internal forward power control circuit also monitors this point.
10	14	12	<b>ANALOG EARTH.</b> General analog earth common for VF input and output.
2	7	13	<b>TEMPERATURE OUTPUT.</b> The temperature output voltage is proportional to the temperature on the power amplifier heatsink.
9	15	14	<b>TRANSMIT AUDIO INPUT 600<math>\Omega</math>.</b> Transmitter audio input to op-amps etc. Nominal line input level is -10dBm. Can handle levels to greater than +10dBm. Common return to analog Earth.
1	8	15	<b>RX RSSI OUTPUT.</b> The receiver's received signal strength indicator voltage is proportional to the log of the signal level at the antenna input. Voltage range is 0 to 5 volts. Output impedance is low. Dynamic range > 60dB.
NC	NC	16	<b>WIDE BAND TX MODULATION INPUT.</b> Wide band audio or data may be connected to this point. <b>WARNING:</b> In order to conform to transmitter bandwidth emissions limits, the signal <b>MUST</b> be pre-filtered. Failure to do this WILL result in non-compliance of the Tx emission spectrum. This input is not normally used except in special cases.

## DB25 Digital I/O Connector

Each CMOS logic input is protected by a 10K Ohm series resistor to the input of the logic chip. There is also a 10K Ohm pull down resistor at each input so as to default the input value to zero.

Each logic output is protected by a 1K Ohm series resistor from the output of the logic chip.

Pin Number And Description:

	Digital I/O DB25 Female Rear Connector (standard connection)			Digital I/O DB25 Male Rear Connector			Internal Circuit Board Header SKF Connector		
13	1	1	<b>DIGITAL EARTH</b>						
25	14	2	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 0.						
12	2	3	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 1.						
21	15	4	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 2.						
11	3	5	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 3.						
23	16	6	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 4.						
10	4	7	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 5.						
22	17	8	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 6.						
9	5	9	<b>INPUT PORT A.</b> Spare 8 bit Logic Input bit 7.						
21	18	10	<b>INPUT PORT B.</b> BCD Channel Select Units bit 0.						
8	6	11	<b>INPUT PORT B.</b> BCD Channel Select Units bit 1.						
20	19	12	<b>INPUT PORT B.</b> BCD Channel Select Units bit 2.						
7	7	13	<b>INPUT PORT B.</b> BCD Channel Select Units bit 3.						
19	20	14	<b>INPUT PORT B.</b> BCD Channel Select Tens bit 0.						
6	8	15	<b>INPUT PORT B.</b> BCD Channel Select Tens bit 1.						
18	21	16	<b>INPUT PORT B.</b> BCD Channel Select Tens bit 2.						
5	9	17	<b>INPUT PORT B.</b> BCD Channel Select Tens bit 3.						
17	22	18	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 0.						
4	10	19	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 1.						
16	23	20	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 2.						
3	11	21	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 3.						
15	24	22	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 4.						
2	12	23	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 5.						
14	25	24	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 6.						
1	13	25	<b>OUTPUT PORT C.</b> Spare 8 bit Logic Output bit 7.						
NC	NC	26	<b>NOT CONNECTED</b>						

## PC Serial Port to Radio Cable

	Signal Name	DB9 PIN#
TD	Transmitted Data	2
RD	Received Data	3
SG	Signal Ground	5

Also see Testing Section

## Appendix C      DIP Switch Settings

### DIP Switch 1      Channel Selection

There are three methods available for channel selection (see also the section MX800 Base Station Utility).

**Software Channel Select via Utility Program:** First ensure that channel 0 is selected on the DIP switch DIP1 located on the Micro Controller Board (all 8 switches in the off position). Enter the channel number in the Software Select Channel window on the Channel Info screen and press Select.

**Software Channel Select via Serial Command:** First ensure that channel 0 is selected on the DIP switch DIP1 located on the Micro Controller Board (all 8 switches in the off position). Send the string "chansXXX" where XXX = a 3 digit number for the channel number. eg To select channel 5 send the string "chans005". Baud rate is 9600 BPS.

**Hardware Channel Select:** Select the fixed channel for the MX800 by using the DIP switch DIP1 located on the Micro Controller Board. Channel 1 to 255 is available in binary selection. Switch position 1 is channel 1, position 2 is channel 2, position 3 is channel 4, position 4 is channel 8, position 5 is channel 16, position 6 is channel 32, position 7 is channel 64, position 8 is channel 128.

A table of DIP switch 1 settings follows, where switch ON is indicated by a "x" in a cell and no entry in a cell represents a switch OFF.

Channel	SW 1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
0								
1	x							
2		x						
3	x	x						
4			x					
5	x		x					
6		x	x					
7	x	x	x					
8				x				
9	x			x				
10		x		x				
11	x	x		x				
12			x	x				
13	x		x	x				
14		x	x	x				
15	x	x	x	x				
16					x			
17	x				x			
18		x			x			
19	x	x			x			
20			x		x			
21	x		x		x			
22		x	x		x			
23	x	x	x		x			
24				x	x			
25	x			x	x			
26		x		x	x			
27	x	x		x	x			

28			X	X	X	
29	X		X	X	X	
30		X	X	X	X	
31	X	X	X	X	X	
32						X
33	X					X
34		X				X
35	X	X				X
36			X			X
37	X		X			X
38		X	X			X
39	X	X	X			X
40				X		X
41	X			X		X
42		X		X		X
43	X	X		X		X
44			X	X		X
45	X		X	X		X
46		X	X	X		X
47	X	X	X	X		X
48					X	X
49	X				X	X
50		X			X	X
51	X	X			X	X
52			X		X	X
53	X		X		X	X
54		X	X		X	X
55	X	X	X		X	X
56				X	X	X
57	X			X	X	X
58		X		X	X	X
59	X	X		X	X	X
60			X	X	X	X
61	X		X	X	X	X
62		X	X	X	X	X
63	X	X	X	X	X	X
64						X
65	X					X
66		X				X
67	X	X				X
68			X			X
69	X		X			X
70		X	X			X
71	X	X	X			X
72				X		X
73	X			X		X
74		X		X		X
75	X	X		X		X
76			X	X		X
77	X		X	X		X
78		X	X	X		X
79	X	X	X	X		X
80					X	X
81	X				X	X

82		X			X		X
83	X	X			X		X
84			X		X		X
85	X		X		X		X
86		X	X		X		X
87	X	X	X		X		X
88				X	X		X
89	X			X	X		X
90		X		X	X		X
91	X	X		X	X		X
92			X	X	X		X
93	X		X	X	X		X
94		X	X	X	X		X
95	X	X	X	X	X		X
96						X	X
97	X					X	X
98		X				X	X
99	X	X				X	X
100			X			X	X
101	X		X			X	X
102		X	X			X	X
103	X	X	X			X	X
104				X		X	X
105	X			X		X	X
106		X		X		X	X
107	X	X		X		X	X
108			X	X		X	X
109	X		X	X		X	X
110		X	X	X		X	X
111	X	X	X	X		X	X
112					X	X	X
113	X				X	X	X
114		X			X	X	X
115	X	X			X	X	X
116			X		X	X	X
117	X		X		X	X	X
118		X	X		X	X	X
119	X	X	X		X	X	X
120				X	X	X	X
121	X			X	X	X	X
122		X		X	X	X	X
123	X	X		X	X	X	X
124			X	X	X	X	X
125	X		X	X	X	X	X
126		X	X	X	X	X	X
127	X	X	X	X	X	X	X
128							X
129	X						X
130		X					X
131	X	X					X
132			X				X
133	X		X				X
134		X	X				X
135	X	X	X				X

136				x			x
137	x			x			x
138		x		x			x
139	x	x		x			x
140			x	x			x
141	x		x	x			x
142		x	x	x			x
143	x	x	x	x			x
144					x		x
145	x				x		x
146		x			x		x
147	x	x			x		x
148			x		x		x
149	x		x		x		x
150		x	x		x		x
151	x	x	x		x		x
152				x	x		x
153	x			x	x		x
154		x		x	x		x
155	x	x		x	x		x
156			x	x	x		x
157	x		x	x	x		x
158		x	x	x	x		x
159	x	x	x	x	x		x
160						x	x
161	x					x	x
162		x				x	x
163	x	x				x	x
164			x			x	x
165	x		x			x	x
166		x	x			x	x
167	x	x	x			x	x
168				x		x	x
169	x			x		x	x
170		x		x		x	x
171	x	x		x		x	x
172			x	x		x	x
173	x		x	x		x	x
174		x	x	x		x	x
175	x	x	x	x		x	x
176					x	x	x
177	x				x	x	x
178		x			x	x	x
179	x	x			x	x	x
180			x		x	x	x
181	x		x		x	x	x
182		x	x		x	x	x
183	x	x	x		x	x	x
184				x	x	x	x
185	x			x	x	x	x
186		x		x	x	x	x
187	x	x		x	x	x	x
188			x	x	x	x	x
189	x		x	x	x	x	x

190		X	X	X	X	X		X
191	X	X	X	X	X	X		X
192							X	X
193	X						X	X
194		X					X	X
195	X	X					X	X
196			X				X	X
197	X		X				X	X
198		X	X				X	X
199	X	X	X				X	X
200				X			X	X
201	X			X			X	X
202		X		X			X	X
203	X	X		X			X	X
204			X	X			X	X
205	X		X	X			X	X
206		X	X	X			X	X
207	X	X	X	X			X	X
208					X		X	X
209	X				X		X	X
210		X			X		X	X
211	X	X			X		X	X
212			X		X		X	X
213	X		X		X		X	X
214		X	X		X		X	X
215	X	X	X		X		X	X
216				X	X		X	X
217	X			X	X		X	X
218		X		X	X		X	X
219	X	X		X	X		X	X
220			X	X	X		X	X
221	X		X	X	X		X	X
222		X	X	X	X		X	X
223	X	X	X	X	X		X	X
224						X	X	X
225	X					X	X	X
226		X				X	X	X
227	X	X				X	X	X
228			X			X	X	X
229	X		X			X	X	X
230		X	X			X	X	X
231	X	X	X			X	X	X
232				X		X	X	X
233	X			X		X	X	X
234		X		X		X	X	X
235	X	X		X		X	X	X
236			X	X		X	X	X
237	X		X	X		X	X	X
238		X	X	X		X	X	X
239	X	X	X	X		X	X	X
240					X	X	X	X
241	X				X	X	X	X
242		X			X	X	X	X
243	X	X			X	X	X	X

244			X		X	X	X	X
245	X		X		X	X	X	X
246		X	X		X	X	X	X
247	X	X	X		X	X	X	X
248				X	X	X	X	X
249	X			X	X	X	X	X
250		X		X	X	X	X	X
251	X	X		X	X	X	X	X
252			X	X	X	X	X	X
253	X		X	X	X	X	X	X
254		X	X	X	X	X	X	X
255	X	X	X	X	X	X	X	X

## DIP Switch 2 User Function Select

Switch Number	Description
Switch 1	<b>PTT Delay</b> Inserts a 100mS delay for the Transmitter RF rise time. Must be selected when using a coaxial simplex changeover relay to prevent switching RF power.
Switch 2	<b>Simplex On</b> Selects simplex mode of operation.
Switch 3	<b>Tx Timer On</b> Transmitter is disabled after 2 minutes continuous use.
Switch 4	<b>Repeater On</b> Selects automatic Receiver to Transmitter repeater function. The Transmitter will also have a 2 second 'hang time'.
Switch 5	<b>Tx VCO Cont</b> Enables the Transmitter's VCO to operate continuously in 'hot stand by' mode. This speeds up the Transmitter's rise time to 4mS. <b>Caution:</b> Low level signal leakage may affect the receiver's performance if the Transmitter is on the same frequency.
Switch 6	<b>Tx FSK</b> Generates an FSK test signal. Not normally used.