SPECTRA ENGINEERING PTY LTD

DMR Repeater

Technical Manual

MX950

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All performance figures quoted are typical and are subject to normal manufacturing and service tolerances.

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Regulatory Information

FCC COMPLIANCE

This device complies with part 15 of the FCC Rules.
Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

FCC Interference Warning

Note: This equipment generates, uses and can radiate radio frequency energy. If not installed and used in accordance with this instruction manual, may cause harmful interference to radio communication. Harmful interference is any emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radio communications service operating in accordance CFR Title 47 Part 15.

HUMAN EXPOSURE TO RADIO FREQUENCY RADIATION (FCC)

USA Customers

Warning to comply with the maximum permissible exposure (MPE) limits referenced in 47 CFR 1.1310 , the following minimum safe operating distances must be observed:

MODEL	FREQ. RANGE OPERATION	SAFE OPERATING DISTANCES
MX950N5H	406.1 to 470 MHz	1.84 m*

Canada Customers

The MX950 radio transmitter has been approved by Innovation, Science and Economic Development Canada to operate with the maximum permissible exposure (MPE) limits defined in Radio Communication Apparatus (All Frequency Bands) , RSS-102, Issue 5, March 2015. The following minimum safe operating distances must be observed:

MODEL	FREQ. RANGE OPERATION	SAFE OPERATING DISTANCES
MX950N5H	406.1 to 470 MHz	2.36 m*

* The transmitter antenna(s) must be fixed-mounted on outdoor permanent structures.
Calculations based on folded dipole typ. gain 3.6dBi

INDUSTRY CANADA COMPLIANCE (ISED)

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

FRENCH:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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Record Of Changes

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

Date	Version	Chapter Changes	Pages Changed
June 2022	1.0.0	All - Initial Release	All

SAFETY SUMMARY

Only the MX950 self contained power supply, if installed, contains dangerous mains voltages within. Normal operation and use of the MX950 does not expose the operator or service technician to high voltage parts. The power supply is isolated from and maybe removed safely from the main chassis. For servicing, please return to your nearest distributor. No fuses or user-serviceable parts are within the power supply module.

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 minimise any possible shock hazard from an external power supply or lightning strike, the chassis or equipment cabinet must be connected to an electrical ground. This is normally achieved by the Earth grounding wire within the 3 wire mains cable. 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 authorised distributor.
Any modifications you make to this equipment which are not authorized by Spectra Eng. may invalidate your compliance authority's approval to operate the equipment.

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. Such devices are not normally used in the MX950.

WARRANTY CONDITIONS & PRECAUTIONS

The following conditions are not covered by the warranty of the MX950. Please ensure that the MX950 is not subject to;

1. Over voltage or Reverse Power Supply Voltage.

2. Operation in locations subject to abnormal environmental conditions such as extreme temperatures or ingress of moisture or excessively dusty environments.

3. Operation of the MX950 Transmitter output into an open or short circuit or an incorrectly terminated load. Although a level of VSWR protection is included, greater protection is provided by the addition of a TX RF isolator.

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1. General Description

The MX950 series equipment is a cost effective professional solution with full sub band capability. Packaged in an compact hand portable carry case suitable for instant deployment. DMR applications use 6.25e kHz TDMA Tier 2, conventional mode Repeater. Operating modes can be software upgraded to cater for feature and system release updates.

The MX950 series employs state of the art design and construction methods to deliver a range of high performance, very reliable radio base stations and repeaters. They are ideally suited for use in VHF or UHF two-way voice communications radio systems. Fractional synthesizers' and the two-point modulation method give the added advantage of linear frequency and phase response from DC to 3 kHz for accurate reproduction of voice and low frequency digital signalling systems. The Receiver and Exciter circuits are contained in single special aluminium housing together with the associated audio processing and digital control on a single circuit board. The Power Amplifier is also contained in its own extruded aluminium housing and can be easily removed from the main chassis. The MX950 also incorporates 'Plug and Play' technology and performs automatic self-calibration. A complete module changeover is field replaceable in very short time.

The MX950 employs some unique features in its design and much thought and consultation has been used to provide a product that offers an extreme degree of flexibility for the installer and service person. For example, all options may be easily field retrofitted at a later date. In addition, servicing is simplified with PCB's having all components on one side of the PCB. This permits the Technician to diagnose problems while either still connected in the chassis or powered simply and independently on the test bench.

The flexibility of the MX950 series allows it to be configured for a wide range of applications without removing any covers.

Standard MX950 applications include:

- Analog Voice Repeater
- DMR Repeater

The MX950 incorporates special technical features, of which the key ones are listed below:

- Extremely low conducted emissions
- Extremely low transmitter spurious
- Fast transmitter on time
- Transmitter frequency response down to DC
- Low group delay distortion
- Full sub band RF switching bandwidth
- No re-tune design for receiver and transmitter
- Fully software programmable
- Built in diagnostics

- CTCSS, Full duplex DCS, DMR Colour codes and many other options included as standard
- Programmable channel spacing
- Flash upgradeable

In addition, the MX950 can be fitted with options, not being limited to the following:

- Power supply
- Duplexer
- Batteries for power backup system.

Note: Not all options and features may be available at the time of order. Please also refer to Spectra Engineering's web site for software feature upgrades and additional documentation as available. www.spectraeng.com.au

1.1 Physical Description

The MX950 series equipment is a cost effective professional solution with full sub band capability. Packaged in an compact hand portable carry case suitable for instant deployment. Its 296mm High, 228mm Deep, 174mm Wide and the weight is less than 5.4kg

The unit consists of four main sub assemblies, the main RF assembly, a Power Amplifier Module, Logic controller and rear interface PCB's. These modules are housed in sturdy aluminium and steel case.

The MX950 features a high degree of RFI and EMI screening throughout the design and construction. The receiver and exciter RF circuits are contained in solid aluminium enclosure. The PA module is contained in a special compact and efficient extrusion for minimum harmonic radiation. This design results in low conducted and radiated emissions and minimal susceptibility to RFI and EMI.

User interface is via the rear panel sockets which includes a DC power in , USB and Ethernet ports for software programming and upgrading.

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1.1.1 Front Panel

1.1.1.1 Standard Front Panel

The MX950 front panel provides the user with real time status of the MX950.

Figure 1-1 MX950 Front Horizontal View

- **Mute / Squelch Adjustment**

  The squelch is used to eliminate any annoying background noise when there are no signals present. This is pre-calibrated at the factory, to provide the user with 5 useable settings. These can be set via the channel edit menu.

  When the Squelch is Open, the receiver's background noise can be heard and ' RX A or B ' is lit on the front panel display. When the Squelch is closed, the receiver remains quiet when there are no signals present but any incoming signals will override the Squelch and will enable the TTR function.

  When CTCSS/DMR colour code is enabled the channel remains quiet until someone transmits using the same tone/colour codes. When the transmission ends, the channel becomes quiet again. By using different tones\colour codes, several groups of people can share the same channel without disturbing each other. DMR also extents this via talk groups.

  NOTE: If an incoming signal is very weak and is close to the minimum squelch level, it may become broken or "chopped" by the squelch action. To prevent this, simply decrease the squelch to allow the signal to be heard clearly. Alternatively, you can reduce the squelch sensitivity as described above to block out unintentional weak signals.

Table 1-1 below explains the functions of the front panel LED's. Each LED indicates the status of the MX950 in real time.

LED	COLOR	FUNCTION
POWER	White	White only on initial power up and will change to one of the colours below. No display indicates the voltage is not normal.
	Blue	Current Channel programmed for DMR mode
	Green	Current Channel programmed for FM mode.
	YELLOW	Current Channel programmed for Mixed mode. (DMR/FM)
	RED	Indicates the power supply voltage is not within limits.
RX	Blue	Analog Mode: A signal is being received by the receiver or the receivers squelch is open. Digital Mode: Inbound Slot 1 is receiving the receivers squelch is open.
	Green	Analog Mode: A signal is being received by the receiver or the receivers squelch is open.
	YELLOW	Digital Mode: Inbound Slot 2 is receiving the receivers squelch is open.
	Purple	Digital Mode: Inbound Slot 1 & 2 is receiving the receivers squelch is open.
TX	BLUE	Digital Mode: Outbound Slot 1 is transmitting
DIGITAL	RED	Analog Mode: The transmitter is transmitting RF power.
TX A	YELLOW	Digital Mode: Outbound Slot 2 is transmitting
TX B	Purple	Digital Mode: Outbound Slot 1 & 2 is transmitting
ALARM	RED	A prearranged alarm condition exists. ALARM: PA over temperature; or ALARM: Low Power shut down; or ALARM: Low power supply voltage; or ALARM: High power supply voltage;
	GOLD	ALARM: High reflected power); or ALARM: Low forward power; or ALARM: Tx VCO unlocked;
	Blue	ALARM: Rx VCO unlocked; or ALARM: PA calibration

Table 1-1 LED Functions

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1.1.1.2 Rear Panel

Conn Type	Function	Description
Mini-Fit Jr ,4P	DC Power input	13.8 Volt DC power input.
N TYPE	N type RX input	The input to the receiver for full duplex operation.
N TYPE	TX output	The RF power output from the transmitter for full duplex operation.
RJ45	Ethernet	Gives the base station an identity as a network element, and provides the physical connections for the Ethernet
USB	USB TYPE B	Serial Data interface.

Table 1-2 Rear Panel Connections

Figure 1-2 MX950 Rear Panel.

(RF Connecting cables not shown)

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1.2 Module Functional Description

1.2.1 RF Module and Main Controller Assembly

The MX950 consists of a full duplex RF module with its own shielded metal housing and a Main Controller board integrated on a single PCB. Using advanced yet simplified circuit designs, the size and complexity is reduced. This affords a number of advantages including;

- Cost reduction
- Reduced number of components improves reliability and MTBF
- Consistent and improved manufacture
- Elimination of connectors and cabling
- Reduction of human error
- Faster maintenance or swap out

The Exciter module generates the low level, on frequency, RF transmitter signal which is later amplified to nominal output power level by the Power Amplifier module. The exciter consists of a Voltage Controlled Oscillator (VCO) and associated main RF board, which, in conjunction with the reference oscillator and the PLL circuitry, forms a two-point modulation programmable frequency synthesiser. Frequency programming data is received from the Micro Controller via an 3 wire serial data bus.

The exciter circuitry features a modulation bandwidth from DC for accurate CTCSS and DCS generation and a wide RF switching bandwidth which covers the entire sub-band. The average maximum RF output power is > +24.7 dBm / 300 mW. Normally no adjustments are required, however should the carrier freq need re-alignment for future maintenance, the TCXO reference oscillator frequency can be adjusted manually or electronically adjusted via software settings.

The fractional N synthesiser provides ultra low spurii while still maintaining fast lock times. The frequency step size is auto determined at 5.0 kHz or 6.25 kHz.

The receiver section accepts the low level RF input signal and amplifies, filters and conditions the signal prior to detecting the wanted audio component. The Receiver features the same advanced synthesiser and wide bandwidth as the exciter. The front end bandpass filter uses very high tolerance components to minimise production spread variations has a wide bandwidth and eliminates the need for future alignments. The bandwidth is equal to the band allocation (refer to Section 5.4 for details of the band allocations). The VCO has low phase noise and covers the full sub-band.

The receiver has high sensitivity while maintaining excellent Intermodulation immunity and adjacent channel rejection. A dual first IF filter provides excellent rejection to common known spurious responses. High blocking of over 100 dB typical ensures that strong interfering signals do not desensitise the receiver when receiving weak signals.

The Micro Controller section is physically located towards the centre on the main board and controls all signal connections (apart from the RF connections). It controls the operation of the RF sections and acts as the interface between the user controls, indicators and the RF sub sections. Together with the VF DSP chip, processed

transmit and received audio is passed to and from the Exciter and Receiver sections as well as providing all other audio signalling functions of the transceiver.

An on onboard EEPROM stores all of the user channel related data such as frequencies, CTCSS tones etc. A serial port at the Microphone accessory socket of the MX950 provides access to the Controller card software configurations for the purpose of the user to create and change this channel related information.

Special functions capable of being carried out include non-predictive full duplex CTCSS encoding/decoding, DCS encoding/decoding, DMR Colour codes. Digipots under the control of the processor ensure that user set up levels for TX deviation and power levels are correctly set for each channel.

1.2.2 Power Amplifier Module

The PA receives the low level modulated RF signal from the Exciter RF output and amplifies and filters it to final output power level. Forward and reflected power voltages are fed to the Micro Controller.

The PA is very compact and efficient for high reliability and low cost. The heatsink has minimal temperature rise even under continuous operation, ensuring the best MTBF obtainable for a practical design. A low loss 13 element elliptical low pass filter ensures that harmonics remain below –90 dBc. The new PA module uses the latest LDMOS technology and using only two active RF transistors improves efficiency and increases the operating bandwidth. At the same time this reduces the number of components used and further improves the long term reliability.

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2. Installation and Operation

2.1 Installation

The MX950 Radio is securely packed for transport within a pasteboard container. Before unpacking the MX950 radio, please inspect the packaging for signs of damage and report any damage to your MX950 distributor.

Upon unpacking of the MX950 radio, please ensure that all items shipped were received, report any missing items to your MX950 distributor.

Check the fan is free or does not look blocked as operation of the radio will be affected if any packaging or shipping damage causes the fan to stop working.

If you intend to install the radio in an equipment rack consult the suppliers instructions for your system. 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. It is recommended that the chassis is earthed to the equipment rack.

Equipment connection details are located in Appendix 5.1. The MX950 will draw approximately 15 to 17A (band dependent) for 100 Watts, <10A for 50W model on transmit and the gauge of the DC cable fitted to the 12V supply connector should be adequate to ensure less than 0.5V volt drop at this current.

2.2 Screw Head Types

Modern screws employ a wide variety of drive designs, each requiring a different kind of tools to drive in or extract them. Spectra Engineering has chosen the **Pozidriv** ® screw head and screwdriver as it preferred screw type on all of its products, sizes 1 & 2. This is because the Pozidriv system is the choice for high volume assembly operations. It provides self-centring system and excellent driving control with less operator fatigue.

It is similar to the classic Phillips cross-head. The differences lie in the way that the heads are machined. The Phillips head has 4 simple slots cut out of it, whereas in the case of the Pozidriv each slot is the result of two machining processes at right angles. The result of this is that the arms of the cross are parallel sided in the case of Pozidriv, and tapered in the case of Phillips. The Pozidriv has four additional points of contact, and does not have the rounded corners that the Phillips screw drive has.

Phillips screwdrivers will usually work in Pozidriv screws, but Phillips screwdrivers are likely to slip or tear out the screw head when used in Pozidriv screws. It is important that you use the correct type and size screwdriver to avoid damaging the screw head.

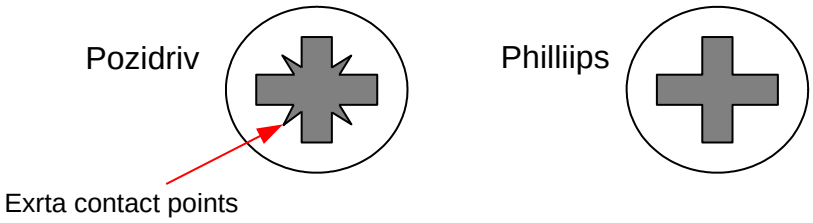

Figure 1-1 Top view of screw heads

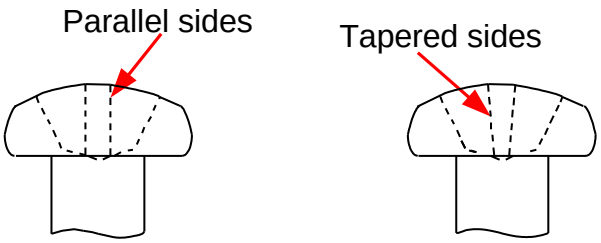

Figure 1-2 Side View of screw Heads

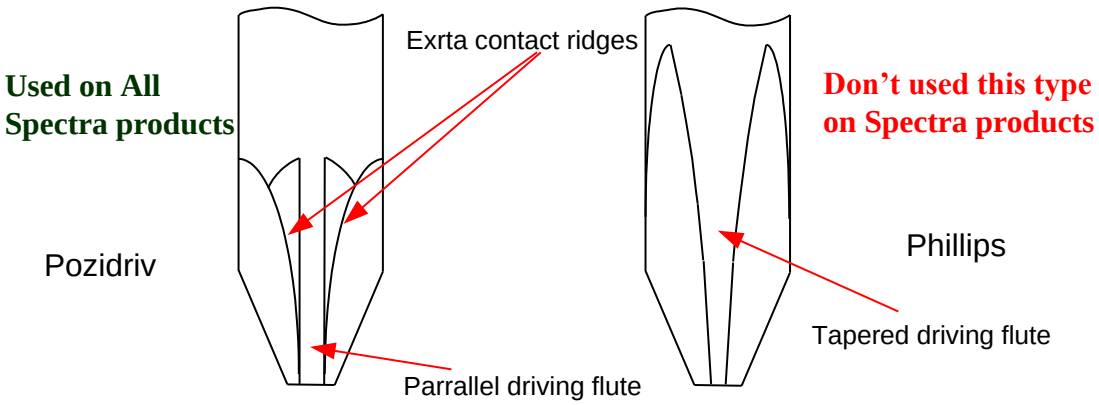

Figure 1-3 Screw driver Tip View

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2.3 Operation

The MX950 can operate in local control Base Station mode or Repeater mode via the front panel controls. Setting up the MX950 to operate in the wanted settings is straightforward and involves one main step.

- Using a PC or handheld serial computer running standard communications terminal software, connect the PC USB port to the radio USB -type B socket at the rear panel of the MX950. Set the appropriate parameters as required.

Note: All MX950s' are set up with a standard default configuration. Test frequency are stored within the MX950 as supplied from Spectra's factory, however these are not normally accessible and each station is supplied with no test channel .

2.3.1 Setting to Work

The following sections describe the steps necessary to set the MX950 to operate as required.

2.3.1.1 Micro Controller Jumper

There is two jumper located on the main Micro Controller J1 & CNVSS. CNVSS is used for selecting the microcontroller operation mode. The user will not normally have to change the position of this jumper as it is only used in the initial factory setup.

J1 is for RF power control type selection. This should always be set to D.

Table 2-1 below summarises the functions of the jumper.

JMP	Function / Description	Default Selection	Default Position
JMP 1 / CNVSS	Selects either default single chip mode or microprocessor mode for the microcontroller.	Single chip mode	Fitted - ON
J1	RF power control type selection D = Discrete PA H = Hybrid PA	Discrete PA	Fitted ON 'D'

Table 2-1 Micro Controller Jumper

2.3.1.2 Select Operating Mode

The MX950 can operate in a number of different modes. The primary alternatives are full duplex repeater, which is the default mode and simplex. Using the built-in radio configuration menu system, the operating mode is programmed for each channel. When a channel is selected in operation, the MX950 adopts the mode programmed for that channel.

2.3.1.3 Select Operating Channel

The MX950 has a channel capacity of 127. The RF frequencies setting for each channel are programmed using the radio configuration menu system channel edit screen. The operating channel is set via a Software channel command to the radio to select the channel. i.e CH001 <ENTER>

2.3.1.4 Configure Alarm LED

The MX950 has an LED to display the status of alarms. The alarm trigger conditions can be set using the built-in radio configuration menu system software. The LED can be set to trigger on low forward power, high reflected power, power supply voltage out of range, VCOs unlocked and high PA temperature. The status of the alarm conditions can be expanded in the on-line diagnostics mode.

Please refer to the radio configuration menu system for additional setup information.

2.3.2 Adjustments

The MX950 has adjustable parameters which are under the control of the Micro Controller. These comprise of TX power, TX VCO deviation, TX reference oscillator deviation and TX reference oscillator frequency. All of these are adjusted with the aid of the built-in radio Alignment menu system. The MX950 comes pre-aligned from the factory, so in most cases no alignment will not be necessary.

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3. Options

The MX950 also has the provision to mount a Duplexer internally using the a optional mounting plate. Wiring for this cases must be performed by the appropriate qualified personal. Please contact your Dealer or Distributor should you require the appropriate assistance.

4. Alignment and Testing

The MX950 test and alignment section assumes that the radio is a working module.

Due to ongoing development the instructions may vary please refer to www.spectraeng.com.au for updates.

4.1 Transceiver Setup, Calibration and Alignment

This section explains how to setup, calibrate and align the complete MX950 Base Station. A number of procedures are required to fully initialise the MX950. The following test equipment will be needed:

- A PC with a terminal emulator to run the built-in radio configuration menu system software
- RF Test Set (HP 8920) or equivalent
- CRO (Cathode Ray Oscilloscope)
- RF Power Meter (Watts)
- RF Signal Generator
- Multimeter
- +13.8V DC power supply

The order of some, but not all, of the procedures is important to ensure correct setup of the radio. The order of the procedures as described is recommended and those that are critical are mentioned. If the radio has been previously setup and the user intends to recalibrate and align the radio then steps 4.1.1, 4.1.2 and 4.1.3 can be ignored as the model number, serial number, configuration and channel information will have already been loaded.

Using a PC or handheld serial computer running standard communications terminal software, connect the device USB port to the Rear USB 'B' type socket at the rear panel of the MX950..

4.1.1 Setting the Model Number and Serial Number

The user cannot alter the serial and model number, as this is factory set.

4.1.2 Setting the Configuration Information

Firstly the basic configuration information for the radio needs to be setup, this is done at the factory. Using in-built menu system, changes to the configuration information needs to be filled out on the Configuration Screen. Once the configuration information has been set then all of the programmable parameters within the MX950 Base Station are initialised.

4.1.3 Adding and Setting Channel Alignments

The MX950 channel frequencies, subtones and other parameters are setup in the channel edit screen of the radio Channel Edit Menu system and then downloaded to the MX950.

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The channel may be edited via the Channel Edit Screen of the built menu system software. The current operational channel can be selected by using the software channel select command.

The MX950 comes from the factory pre-aligned, so in most cases adjustment will not be required. The MX950 employs Frequency Alignment Compensation, which is setup during factory alignment.. This reduce the need of individual channel alignment for Tx Power and modulation depth. If however adjustment are required on a particular channel this can be done via the built in alignment menu. See section 4.1.8 for TX power adjustments and section 4.1.9 for modulation alignments.

4.1.4 Setting CTCSS/DCS

MX950 Controller CTCSS Setup:

1. The RF channels that are required to be CTCSS controlled should be programmed with the required CTCSS Subtone in the TX and / or RX channel fields.

MX950 CTCSS / DCS Testing:

1. The use of the DCS / CTCSS encoder / decoder will require a 'Peak Deviation and Modulation Balance Alignment' as per Section 4.1.9 of the Technical manual. This alignment is to be performed without the CTCSS frequencies or DCS codes programmed into the alignment channel as the subtone levels will give a false indication of the peak deviation levels. The MX950 contains circuitry that automatically scales the deviation so the nominal deviation is not exceeded when a sub tone is transmitted.

4.1.5 Power Calibration

DO NOT USE THIS PROCEDURE TO SET THE TX OUTPUT POWER. REFER 4.1.8 TX POWER ADJUSTMENT TO DO THIS.

Power calibration affects the forward and reflected power meters on the Diagnostics Screen. This procedure requires a power meter and the relevant leads to connect the transmitter output to the meter. Power calibration is done using software commands. To complete the power calibration send the command CALP <enter>, and follow the instructions that Built in menu system provides.

These readings are subsequently used for the real-time update and display of the VSWR. The live VSWR values are used in the PA protection routines in the firmware.

4.1.6 RSSI Calibration

The RSSI calibration is used to calibrate the RSSI meter on the in-built menu system via Diagnostics Screen. The procedure requires an RF signal generator and the relevant leads to connect the signal generator to the RF input of the MX950 Base Station. RSSI calibration is done via software command To complete the RSSI calibration send the command CALR <enter>, and follow the instructions that in-built menu system provides.

4.1.7 Temperature Calibration

The temperature calibration is used to calibrate the temperature meter on the in-built menu system via Diagnostics Screen and the temperature controlled switch/alarm points. The procedure requires dummy cable for SKB on the micro controller having a 2060-ohm resistor between pins 4 and 6 of this connector of the MX950 Base Station. Temperature calibration is done via the software command. To complete the temperature calibration send command CALT <enter>, and follow the instructions that in-built menu system provides.

4.1.8 TX Power Adjustment

The MX950 employs SMART PA® technology. This provides hassle free power setting. This means that the user can type in a direct Power level in the channel edit menu. E.g. 50W.

If however the required power level is not achieve a manual alignment can be done on a per channel basis via the alignment menu.

4.1.9 Peak Deviation and Modulation Balance Alignment

This procedure is used to set the peak deviation and modulation balance for each channel. This is done on a per channel basis. The alignment is done using the Alignment Screen in the built menu system . To carry out this procedure the demodulated output of the transmitter output needs to be connected to a CRO or some other piece of equipment giving a visual display of the demodulated output. IF Bandwidth of the RF test set should be set at 20kHz or greater (230kHz on the HP 8920) and de-emphasise should be off. The audio filters should be set at <20Hz HPF and 15kHz LPF.

The peak deviation is aligned on wide band and without CTCSS\DCS Tone enabled. The following table specifies the peak deviation to align to.

Bandwidth	CTCSS Option	Peak Deviation (Hz)
Narrow (12.5kHz spacing)	NO	2250

Table 4-1 Peak Deviation Settings

The test tones used in this routine are generated internally and are a 1 kHz square wave for the transmitter deviation and a 400 Hz square wave for the modulation balance.

Procedure:

1. Using in-built menu system, select --- ALIGNMENT MENU –
2. Select Tx Deviation and Modulation Balance - current channel (O)
3. The radio will now transmitter.
4. Follow the built in menu system instructions.
5. The transmitter will be modulated with test frequencies (1kHz, & 400Hz tone generators under micro controller control)
6. Adjust the VCO Deviation digital potentiometer using built menu system until the correct deviation is obtained. (See Table 4-1 Peak Deviation Settings).

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7. Adjust the Reference Deviation digital potentiometer until the top of the waveform is flat. If the waveform top droops increase the level (see Figure 4-1) and if it peaks reduce the level (see Figure 4-2).
8. Repeat steps 5 through to 9 until the correct peak deviation and modulation balance is obtained.

Examples of incorrect, observed waveforms are as follows:

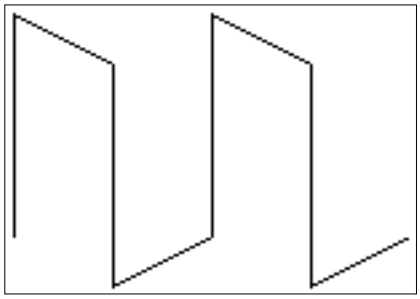

Figure 4-1 Mod Under (increase level)

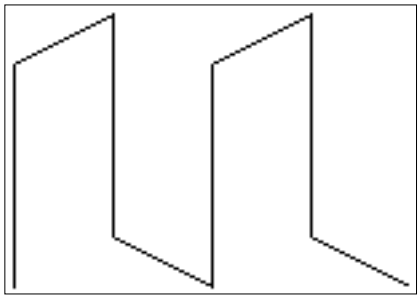

Figure 4-2 Mod Over (decrease level)

The waveform when correctly aligned should look as follows:

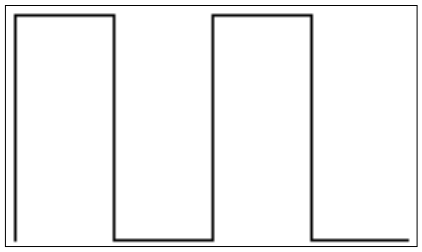

Figure 4-3 Correctly Aligned Waveform

Choose ‘OK’ to accept the changes made. This then saves the changes that you have made to the radio.

After balancing and setting the correct peak deviation is necessary to align the reference oscillator and re-check the deviation alignment, as the reference oscillator alignment affects the deviation. This may require running through the deviation alignment again after the oscillator alignment procedure.

4.1.10 TX Centre Frequency Alignment

The reference oscillator alignment is used to set the correct centre frequency for each channel. This is done on a per channel basis. Oscillator alignment is done using a digital potentiometer adjustment through the Built in menu system. To carry out this procedure the transmitter output needs to be connected to a RF test set displaying the frequency error. This procedure should be done after the deviation alignment procedure has been done. Transmitter modulation we be disabled.

Select Tx Reference Oscillator and Output Power and follow the in-built menus instructions. Alter the Reference Oscillator Frequency potentiometer until the channel is “on frequency”. Choose ‘enter’ to accept the changes made. This then saves the changes that you have made to the radio.

4.1.11 Nominal Deviation

The required nominal deviation is dependent on whether the radio is programmed for either narrow or wide. The following table lists the required level for each case:

Bandwidth	FM Nominal Deviation (kHz)
Narrow (12.5kHz spacing)	1.5
Wide (25kHz spacing)	3.0

Table 4-2 Nominal Deviation

.

4.1.12 Mute Threshold Setting

Test Equipment:

- PC with Terminal software
- RF Communications test set
- +13.8VDC power supply

MX950 Testing – Rx Mute:

1. Monitor the front panel RX Led with the base station connected to a RF Communications test set. Inject the correct RF frequency into the receiver for the test channel. Set the test set generator to the desired muted amplitude (i.e -119dBm) , then set the squelch level (i.e. 2) via programmer or Using in-built menu system channel edit screen. Test your setting by reducing the RF generator amplitude until RX Led is off .

2. Re-adjust the squelch level (Mute control) so that the RX just goes into the muted condition RX Led off, for the desired RF amplitude.

   Ideally, the squelch level should be set just above the background radio noise level or at the point where the typical desired signal is becoming too noisy to be acceptable. A higher setting of squelch level requires higher received signal strength to un-mute the receiver. A “0” level indicates that there is no squelch suppression function, which is the lowest level.

Further information on setting mute (squelch) can be found in Section 1.1.1

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5. Appendices

5.1 MX950 Interface Connections

The user connections to the MX950 are all made via the Front and rear panel where the following connectors are located.

Conn Type	Function	Description
Mini-Fit Jr ,4P	DC Power input	13.8 Volt DC power input.
N TYPE	N type RX input	The input to the receiver for full duplex operation.
N TYPE	TX output	The RF power output from the transmitter for full duplex operation.
RJ45	Ethernet	Gives the base station an identity as a network element, and provides the physical connections for the Ethernet
USB	USB TYPE B	Serial Data interface.

Table 5-1 MX950 Interface Connectors

5.2 Rear interface Board

The rear interface provides the necessary user interface points for the radio. The input supply (+13V8 DC), a USB type B, and the physical connections for the Ethernet and system interface.

5.2.1 Rear User Interface

All user interfaces to the MX950 except the TX RF connections and LEDs are made by way of the Rear interface board .

- CN3 - USB type B Connection for the serial port programming.
- CN4 - DC Supply input , +13V8 DC.
- CN6 - Ethernet connection.

Front panel LED's - See Section 1.1.1.

5.2.2 CN4 Pinouts

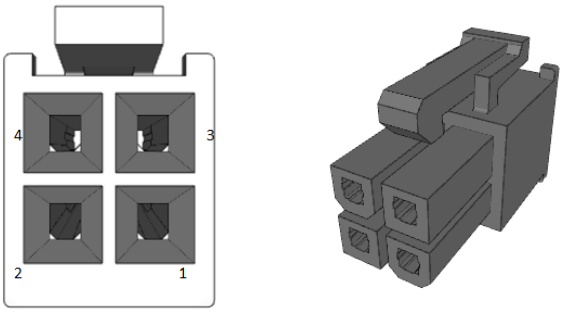

Figure 4.1 CN4 DC INPUT Supply (Mini-Fit Jr Connector)

PINS	Description
1	GND
2	GND
3	+ 13V8 DC
4	+ 13V8 DC

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5.3 MX950 Specifications

Minimum performance to exceed the following for 30 MHz to 960 MHz*:

- AS4295
- ETS 300 086, ETS 300 113, ETS 300 489
- FCC Part 90
- TIA/EIA-603
- CE Marking
- IC (ISED)

*Conforms but may not be approved.

Consult Spectra Engineering regarding current type approvals and for latest and current MX950 Specification Data sheet.

5.3.1 Operating Frequency Bands

The MX950 is available in a number of models, which cover the range of operating frequency bands. Refer to Section 5.4 for details of the band breakdown.

5.3.2 General

Parameter	Specification
MX950 Rack Size:	NA
MX950 Overall Physical Size	296mm high, 228mm deep, 174mm wide * Requires extra depth (40mm) for Fan operation and cable connection.
Weight	<5.4 kg
Supply Voltage:	12V +/- 20%.
Power Consumption:	<500mA receive, typical 480mA. (TX VCO off).
	<10A for 50W TX RF @12VDC.
Operating Temperature:	-30 to +60 C.
Individual Module Dimensions:	Main board W=153, L=221mm, H = 22mm.
	PA W=112, L=180, H = 95mm.
Standard LED indicators:	PWR, RX, TX, ALARMS SEE Table 1-1 LED Functions
Frequency Range:	Coverage 148-520 MHz , Model dependent.
Synthesis Method:	Non mixing PLL Fractional N synthesiser.
Modulation:	DMR voice and data, Direct FM, two point method,
	+/-2.5 kHz narrow band, +/- 5 kHz wide band
Channel Spacing:	25 kHz or 12.5 kHz, software selectable.
Synthesiser Step Size:	5 kHz or 6.25 kHz.
Channels:	127 Software selectable.

Table 5-2 General Specifications

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5.3.3 Transmit

Measured in accordance with TIA/EIA-603 standards.

Parameter	Specification
RF Power Output:	1W to 50W or 100W (See model type)
Frequency Stability: > 300 MHz < 300 MHz	1.0 PPM for –30 to 60C, 2.5PPM for –30 to 60C,
Audio response:	Flat within +1, -3 dB across bandwidth
Audio Bandwidth VF input:	300 Hz to 3000 Hz LPF
Modulation Distortion:	Less than 3% at 60% deviation.
S/N Ratio:	Better than 50 dB, wide band.
	Better than 45 dB, narrow Band.
Spurii:	Better than –90 dBc.
RF Switching Bandwidth Exciter:	Full sub-band.
RF Switching Bandwidth PA:	Full sub-band.
Duty Cycle:	100% for 50W or 100W RF output with thermally controlled fan.
RF Rise Time:	< 10 mS with continuous VCO selected. < 100 mS with VCO in cold standby.

Table 5-3 Transmit Specifications

5.3.4 Receive

Measured in accordance with TIA/EIA-603 standards.

Parameter	Specification
Sensitivity:	Better than –117 dBm for 12 dB SINAD. Typical –121 dBm.
Selectivity 135-520MHz:	More than 82 dB for 25 kHz adj channel. Typical 85dB More than 75 dB for 12.5 kHz adj channel.
Spurious Resp:	Better than 80 dB.
Intermodulation:	82-88 dB.
Blocking:	Better than 100 dB at +/- 1 MHz point.
Co-Channel Rejection:	Better than 5 dB.
Distortion:	Less than 3% at 60% deviation.
S/N Ratio:	Better than 50 dB wide band. Better than 45 dB narrow band.
Receiver Front End BW:	Equal to band allocation.
Audio Bandwidth VF output:	300 Hz to 3000 Hz, +1/-3 dB.
Conducted Spurious:	Less than –57dBm.

Table 5-4 Receive Specifications

5.3.5 Ancillaries

Parameter	Specification
TX Timer:	Programmable, on / off selectable.
Pre-Emphasis Accuracy:	Within +1, -3 dB of 6 dB per octave curve.
De-Emphasis Accuracy:	Within +1, -3 dB of 6 dB per octave curve.
Channel Select:	Software Select
Repeater Tail Timer:	Programmable.

Table 5-5 Ancilary Specifications

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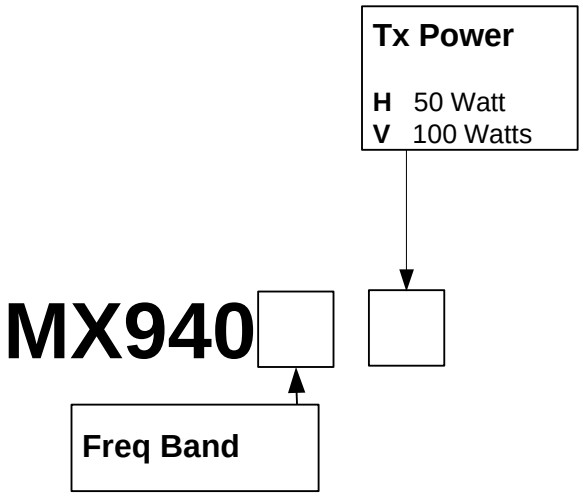
5.4 MX950 Model Number Configuration Guide

The MX950 build can be specified by the model number. The diagram below shows how the model number is derived from the wanted options. Consult Spectra for availability details on specific configurations and options.



Band	Frequency
D5°	148-174 MHz
N5	400-470 MHz
P5°	450-520 MHz

Table 5-6 MX950 frequencies bands

Due to ongoing development please refer to www.spectraeng.com.au for the latest revision of the specifications.