SPECTRA
ENGINEERING

Base Station, Repeater, Receiver and
Transmitter

MX800

Technical Brief

Spectra Engineering Pty Ltd
ABN 65 057 696 438

9 Trade Road
Malaga
Western Australia 6090

Tel: +61-8-92482755 Fax: +61-8-92482756

Email: info@spectraeng.com.au
Web: www.spectraeng.com.au

Tech Brief Revision 6.0 May 2005

In order to continually improve our products, Spectra Engineering Pty Ltd reserves the right to alter, without notice and at any time, the equipment and specifications described in this document.

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

The purchaser is warned that statements made in this document may be inaccurate due to typographical or other errors or subsequent modifications of the product. While every care has been taken in the creation of this document, no warranty of accuracy or reliability is given, in any advice or information contained in this document. The responsibility for any loss or damage whatsoever arising in any way or any representation, act or omission whether express or implied (including responsibility to any person by reason of negligence) is not accepted by Spectra Engineering Pty Ltd or any director, officer, agent or employee of Spectra Engineering Pty Ltd.

FCC Interference Warning

Note: The equipment has been tested and found to comply with the limits for a class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial or residential environment. 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.

For more detailed information please refer to the MX800 Technical manual

General Description

The MX800 series employs state of the art design and construction methods to deliver a range of high performance, ultra reliable radio transceivers. They are ideally suited for use in VHF or UHF two way voice radio systems, however, the MX800 can perform in a range of applications where the added advantage of linear frequency and phase response from DC to 3.4kHz can be utilised. The MX800 uses a two-point modulation method synthesiser for extended low end VF transmit frequency response. The Receiver, Exciter and Power Amplifier are contained in their own specialised aluminium module and can be easily removed from the main chassis.

The flexibility of the MX800 series allows it to be configured for a wide range of applications.

- Standard MX800 applications include:
- Conventional 2-Way voice base station
- Full duplex or simplex base station
- Radio modem base station
- Direct FSK or SELCALL baseband repeater
- Trunking base station for MPT1327, LTR, SmartTrunk and others
- Analog Cellular base station
- POCSAG paging transmitter to 2400 BPS
- POCSAG repeater
- DC-coupled Direct FSK modulation system
- Voice repeater
- Wide band data repeater
- DC-coupled repeater
- Point to point link
- Fast 25mS repeater for multi hopping
- Cross band link or repeater
- Simulcast transmitter
- Quasi-Sync offset transmitter

The MX800 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
- Very Wide RF switching bandwidth
- No re-tune receiver or transmitter
- Fully software programmable
- Built in diagnostics
- Trunking control and VF routing interface
- Built in community multi-tone style repeater
- High stability reference input for Simulcast systems

In addition, the MX800 can be fitted with many options, not being limited to the following:

- Programmable channel spacing
- Programmable CTCSS / DCS encoder and decoder
- Isolated VF and E&M lead interfaces
- Simplex antenna changeover relay
- VF audio delay for noiseless mute/squelch/repeater function
- Low receiver standby current consumption
- External reference oscillator input
- Local speaker and microphone
- Push wheel channel selector
- High stability options
- Audio Facilities board covers many new features
- Internal Modem or Ethernet interface
- Special high performance receiver options

Other custom features on special request

For further information, please contact Spectra Engineering.

Physical Description

The MX800 is a compact lightweight standard 19" rack mounting transceiver. It is designed to mount horizontally in a 19" rack frame and occupies 2RU (89mm). The depth of the unit is 330mm and the weight is less than 9kg.

The unit consists of four main sub assemblies an Exciter Module, a Receiver Module, a Power Amplifier Module and a Micro Controller board. These modules are housed in a fully welded steel case.

The MX800 features a high degree of RFI and EMI screening throughout the design and construction. The receiver and exciter (low power transmitter) modules are contained in solid aluminium enclosures, and for additional screening each interface pin in the modules is individually filtered. The PA module is contained in a special compact 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 front and rear panels. The rear panel provides access to all connectors and the standard front panel provides 6 LED indicators of the radio status. The local control option front panel has additional speaker, microphone and (optionally) channel select functions. Other variations can accommodate serial and monitor ports, as well as VF line level adjustment on the front panel.

Front Panel

Standard Front Panel

The MX800 standard front panel is illustrated below. Custom versions of the front panel can be supplied to OEM customers.

Below explains the functions of the front panel LED's. Each LED indicates the status of the MX800 in real time.

LED	FUNCTION
POWER	Indicates the power supply voltage is within software selectable limits.
RX	The receiver is receiving a signal or the receiver's squelch is open.
TX	The transmitter is transmitting RF power.
CTCSS	A valid Continuous Tone Coded Squelch Signal has been detected.
AUX	An Aux function is selected or the PLL is unlocked.
ALARM	A prearranged alarm condition exists.

Table 1 Led Functions

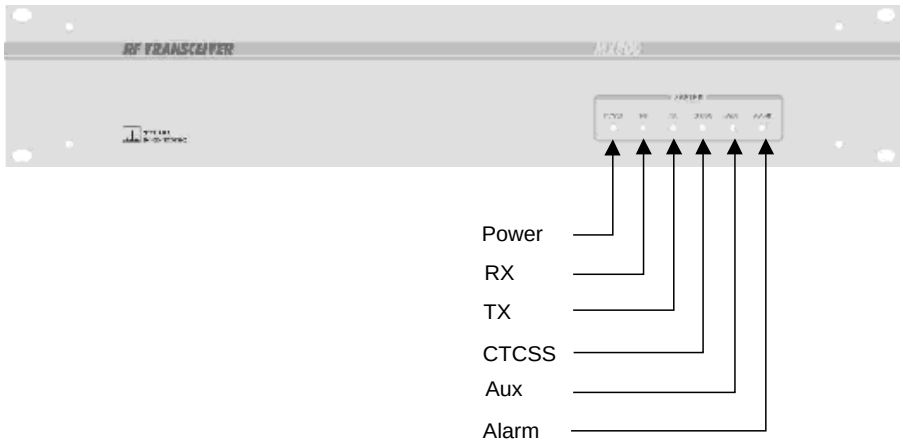


Figure 1 Standard Front Panel

Local Control Front Panel

The Local Control Front Panel is illustrated in Figure 2 below.

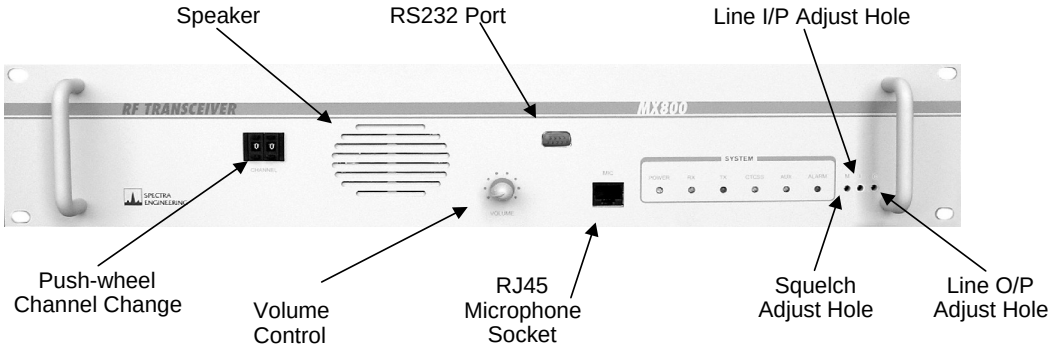


Figure 2 Local Control Front Panel

It has the same LED indicators as the standard front panel as well as the following features

- **Loudspeaker and Volume Control**
  A 1 Watt loudspeaker is provided to monitor 'on air' received audio as well as transmit audio from line. Volume control is provided by means of a potentiometer or a 3-position toggle switch adjacent to the loudspeaker. This switch is biased in the centre position. To raise or lower the volume the switch is momentarily moved up or down respectively. For each switch closure the volume is incremented or decremented a fixed amount. Newer versions of the MX800 Micro Controller PCB support a conventional rotary volume control. The newer versions are also backward compatible in that the circuitry can still support the older up/down control method as well as the new chassis can still accommodate the older revision board.
  The speaker has a link selectable connection to a tone output from the microcontroller. This may be used in conjunction with the appropriate software configuration to generate an alert tone to the user.
- **Microphone Socket**
  An RJ45 socket is provided on the front panel for connection of a microphone.
- **Channel Change Control**
  Twin push-wheel switches can be optionally fitted to the front panel to allow selection of the operating channel. This switch replaces the channel select function normally accessible on CN3 on the rear panel. 100 channels are selectable. Refer to section 0 for channel select method.
- **RS232 and Monitor Ports**
  Provision is made to optionally fit these two connectors on the front panel instead of on the rear panel. The pin-out and functions of these two ports remain unchanged when this is done.
- **Mute / Squelch Adjustment**
  Provision is made to optionally locate the mute / squelch control potentiometer behind the front panel. A screwdriver hole is provided in the front panel to access this adjustment.
- **Line Level Adjustments**
  Provision is made to optionally locate the line I/O level control potentiometers behind the front panel. A screwdriver hole is provided in the front panel to access each of these adjustments.

Note *Note that it is possible to select some features of the Local Control Option and omit others. For example operating channel select from the front panel may not be required (or permitted) and the Local Control Option may be ordered without this feature Refer to section 3.*

Rear Panel

Figure 3 below and Table 2 Rear Panel Connections Details the functions of each connector.

Conn Type	Function	Description
3 PIN	DC Power input	13.8 Volt DC power input. Also +28 Volt input on spare pin if required.
N TYPE	Simplex relay out or N type RX input	Location for internal simplex relay. The antenna for RX / TX connects to this point. Alternatively an 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.
RJ45	Option	Knockout provision for RJ45 connector.
DB25-F	Parallel I/O	Provides one 8 bit input port. One parallel 8 bit BCD or Binary channel select input and one 8-bit output port.
DB15-F	Line I/O	Provides the necessary analog receiver and transmitter interface for system interfacing.
DB9-M	RS-232 serial port	9600 Baud serial port for frequency programming, channel selection and alarm and status monitoring.
DB9-F	Monitor port	Provision for special monitoring of certain internal signals.

Table 2 Rear Panel Connections

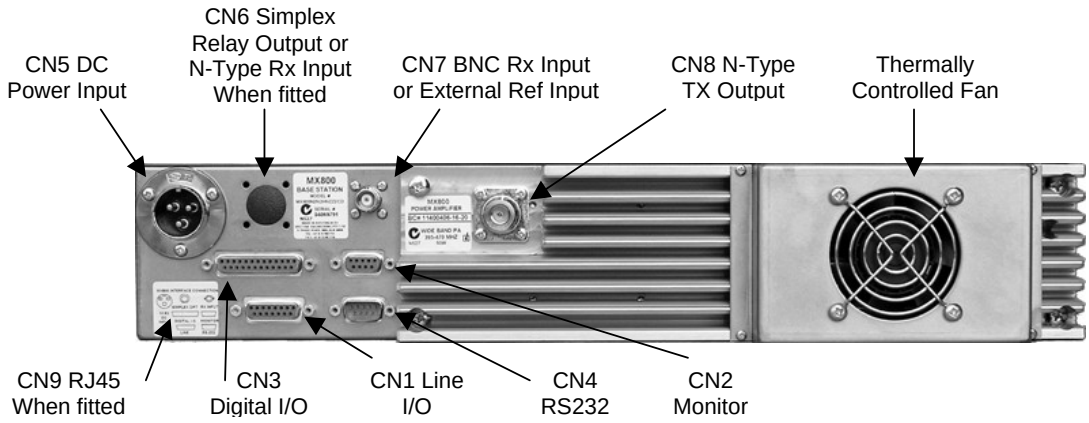


Figure 3 MX800 Rear Panel

Side Panel

The MX800 side view is illustrated in Figure 4 below. Two mounting holes in each side make provision for fitting a slider rail bracket.

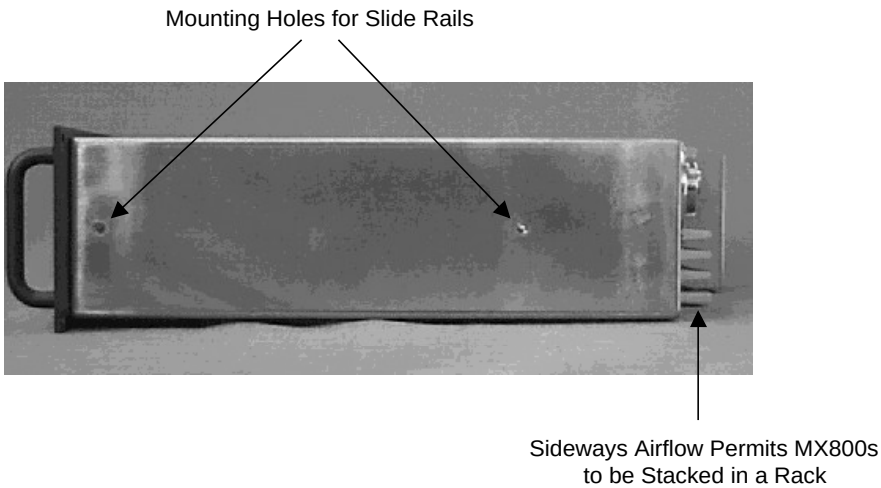


Figure 4 MX800 Side Panel

Module Functional Description

Exciter Module

The Exciter module generates the low level, on frequency, RF transmitter signal that 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 module features a modulation bandwidth from DC with an ultra wide RF bandwidth of 20MHz to 1000MHz at an average RF output power of 300mW. To change from one band to another, all that is required is to change the plug in VCO board and reprogram the radio. No other manual adjustment or change is required.

Should a high stability reference be required, the exciter can be fitted with a connector for an external reference oscillator input.

The fractional N synthesiser provides ultra low spurii while still maintaining fast lock times even at 6.25kHz step size.

An optional built in turn around mixer (TRM) provides advanced diagnostics such as receiver sensitivity tests.

Receiver Module

The receiver module accepts the low level RF input signal and amplifies, filters and conditions the signal prior to detecting the wanted audio component.

The Receiver module features the same advanced synthesiser 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 purpose built front end bandpass filter has a wide no-adjust bandwidth equal to the band allocation (refer to section 7.4 for details of the band allocations).

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 100dB typical ensures that strong interfering signals do not desensitise the receiver when receiving weak signals.

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.

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.

Micro Controller Board

The Micro Controller Board is physically located behind the rear panel connectors and all signal connections (apart from the RF connections) external to the transceiver are made via the controller card. User settable jumpers and DIP switches are located on the card as are level adjustment potentiometers.

The Micro Controller controls the operation of the RF modules and acts as the interface between the user connections, indicators and the RF modules. It processes transmit and received audio to and from the Exciter and Receiver modules as well as providing the digital I/O functions of the transceiver.

The circuit board has an onboard EEROM in which is stored all of the user channel related data such as frequencies, CTCSS tones etc. A serial port at the rear (or optionally the front) of the MX800 provides access to the Controller card and in conjunction with the Spectra Engineering "MXTOOLS" programming utility allows the user to create and change this channel related information.

Special functions capable of being carried out by this card include non-predictive full duplex CTCSS encoding/decoding, DCS encoding/decoding as well as FFSK and 4-level FSK modems. 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.

Operation

The MX800 can operate in local control mode via the front panel controls, stand alone repeater mode, or may be remotely controlled through the line port. Setting up the MX800 to operate in the wanted mode is straightforward and involves four main steps.

1. Using the MX800 programming utility 'MXTOOLS' to set the software configurable parameters.
2. Setting the hardware jumpers on the Micro Controller for the required options.
3. Adjusting the levels where necessary.
4. Making the necessary electrical connections to the radio and your system.

Note that generally if the requirements have been fully specified at time of purchase steps 1 to 3 will already have been done at the factory. In the following sections the hardware aspects of the set up procedure are described.

MXTOOLS Utility

MXTOOLS is a programming utility used to program channel data, configure and perform remote diagnostics on the MX800. It runs on a PC compatible computer and the MXTOOLS Inbuilt help menus cover use of the program.

MX800 Networking

At sites where more than one MX800 is located it is possible to "bus" the RS232 lines to allow up to 16 MX800s at one site to be addressed on a single RS232 port. Hardware facilities provided on the MX800 Micro controller card provide isolation between transmit ports. When MX800s are bussed in this way JMP24 in each radio must be set so that

1. At least one radio and no more than four are set as masters.
2. All other radios are set as slaves.

Refer to Table 3 Micro Controller Jumpers, in section 0 for details.

In addition to this, each radio must be assigned a unique address. This address is assigned as a binary code through CN3. Four address lines are available on input port A where bit 4 is the LSB and bit 7 is the MSB. These lines should be pulled high or low depending upon the setting of JMP19. Default is active low so that GND = Logic 1, Refer section 2.2.2.5.

The RS232 cable should be made up such that all MX800 transmit ports (TXD) are common and connected to the PC receive port (RXD) and all MX800 receive ports (RXD) are common and connected to the PC transmit port (TXD).

MXTOOLS automatically polls the bussed radios to determine which addresses are active when the "Use Network" button is selected in the initial connect screen (MXTOOLS version 2.8.1 or later).

Refer application note AN-MX800-002 for more details on networking, available from www.Spectraeng.com.au web site.

Setting to Work

The following sections describe the steps necessary to set the MX800 to operate as required.

Setting Micro Controller Jumpers

The micro controller layout is contained in the drawing section and the position of the jumpers and DIP switches (highlighted) are shown below. The jumpers and switches are used for setting the general configuration of the audio processing for both the TX and RX paths as well as various miscellaneous functions.

Table 3 Micro Controller Jumpers below summarises the functions of the jumpers.

JMP	Function / Description	Default Selection	Default Position
JMP 1	Selects either default RUN or EMULATE mode for the micro processor.	Run	2-3
JMP 2	Enables the WATCHDOG auto reset function in the microprocessor.	Enabled	1-2
JMP 3	Enables or disables the PRE-EMPHASIS for the TX audio.	Enabled	1-2
JMP 4	Enables or disables the COMPRESSOR for the TX audio.	Enabled	1-2
JMP 5	Enables or disables the HIGH PASS FILTER for the RX audio.	Enabled	2-3
JMP 6	Enables or disables the LOW PASS FILTER for the RX audio.	Enabled	2-3
JMP 7	Enables or disables the DE-EMPHASIS processing for the RX audio.	Enabled	2-3
JMP 8	Enables a direct connection to the TX modulator. Select either Wide Band or Wide Band filtered and limited or nil.	DC-FM	1-2
JMP 9	TX VF Loopback control. Trunking LIFUISEN function. The function polarity or nil can be selected.	Active low	1-2
JMP 10	Controls the direction of the RS-232 TX and RX data.	Swap	2-3

JMP 11	Controls the direction of the RS-232 TX and RX data.	Swap	2-3
JMP 12	Trunking RX Talk function. Disables RX VF to line and TTR VF. The function polarity or nil can be selected.	Active low	1-2
JMP 13	Enables or disables the HIGH PASS FILTER for the TX audio.	Enabled	1-2
JMP 14	Repeater enable. Trunking LIFULOCEN function. The function polarity or nil can be selected. Note that this control is in parallel with DIP S/W 2/3	Active low	1-2
JMP15	Selects the connection for the common pin on the digital I/O connector to either ETH or + 5 volts.	ETH	2-3
JMP16	Enables or disables the Low frequency HPF used for the Repeater VF routing.	Enabled	1-2
JMP17	Selects the Mute / Squelch output polarity to either normally high or low.	Active low	1-2
JMP 18	Trunking TX Talk function. Disables TX VF to line and TTR VF. The function polarity or nil can be selected.	Active low	1-2
JMP 19	Selects either internal pull up to 5V or internal pull down to ETH for digital input on D25 connector	Pull up	2-3
JMP 20 JMP 21	Selects modem discriminator audio source. *Optional PCB fitted* Modem audio via opt PCB: JMP20 fitted JMP21 not fitted Modem audio bypass opt PCB: JMP20 not fitted JMP21 fitted *Optional PCB not fitted* Modem audio bypass opt PCB: JMP20 fitted JMP21 not fitted Note in this case a link is fitted between SKK1 and SKK2	Modem audio disconnected	Both links not fitted

JMP 22	Microphone gain. Fit this jumper to increase Mic gain 33dB	Low gain	Not fitted
JMP 23	Enable tone to speaker. Fit this jumper to enable tone	Disabled	Not fitted
JMP 24	RS232 port termination. This jumper allows an internal termination to be selected or not for bussed RS232 connections. Up to 16 units may be bussed. All bussed bases are 'listeners' on the modem RS232 TX port. All bussed bases have their RS232 TX ports diode to the modem Rx port. Normal: Non-bussed mode. No resistor fitted. D10 out of circuit. Master: Bussed mode. 4K7 resistor across D10. Configure at least one and no more than four MX800 in this mode when multiple units connected. Slave: Bussed mode. D10 fitted, no resistor. Configure balance of bussed units in this mode.	Normal	1-2 1-2 2-3 3-4
JMP 25	Mute defeat enable. Mute defeat cannot be used if RX TALK line is required. To use mute defeat remove JMP12 and fit JMP 25. The control signal polarity can be inverted by changing the position of JMP25. Active low control: JMP25 2-3 Active high control: JMP25 1-2	Disabled	Not fitted
JMP 26	CTCSS output / TX VF Loopback control	TX VF Loopback	2-3
JMP 27	CTCSS input / WB DC-FM input	WB DC-FM input	2-3

Table 3 Micro Controller Jumpers

When the MX800 option card is not fitted there is no connection made to SKK (Aux 2 connector) on the micro controller. Links should be placed across SKK1-2 (Discriminator audio), SKK11-12 (TX supply) and SKK13-14 (RX supply). These links are normally fitted in production.

Select Operating Mode

The MX800 can operate in a number of different modes. The primary alternatives are full duplex, which is the default mode, repeater and simplex. Using MXTOOLS the operating mode is programmed for each channel. When a channel is selected in operation the MX800 adopts the mode programmed for that channel.

The operating mode programmed in the software can be modified by the settings of DIP switch 2. The functions of this switch are detailed in Table 4 DIP Switch 2 Settings below.

SW 2	Function	Description	Def Select
1	PTT Delay	Enables 50mS delay of PTT for use with simplex function.	OFF
2	Simplex Enable	Enables simplex function*	OFF
3	TX Timer	Sets programmable TX time out timer on	ON
4	Repeater Enable	Enables repeater function*	OFF
5	TX VCO on continuously	Switches TX VCO on continuously	OFF
6	Scan on	Selects the receiver to enable the scanning of programmed scan channels	OFF

Table 4 DIP Switch 2 Settings

Note *The Repeater Enable functions as follows:*
If the switch is ON and the channel is programmed as a repeater channel (using MXTOOLS) the MX800 will act as a repeater. If the switch is OFF the MX800 will remain in full duplex mode even if the channel is programmed as a repeater. The Simplex Enable operates in a similar way.

In the case of the Repeater Enable function, the Repeater Enable on Pin 8 of the DB15 Line connector is effectively in parallel with SW2/4. If SW2/4 is OFF the function may be controlled through this external line. JMP 14 selects the control polarity in that case.

Select Operating Channel

The MX800 has a channel capacity of 255. The RF and CTCSS frequencies for each channel are programmed using MXTOOLS Channel Information screen. There are four ways of selecting the operating channel.

1. *DIP Switch 8-way.* DIP switch SW1 provides a binary channel selection facility. When a switch is ON it is read as a logical 1. When all switches are off the software channel select mode is enabled.
2. *Rear channel select port*. Digital input port B provides an 8 way Binary or BCD channel select input. Binary or BCD coding is selected using MXTOOLS. If Binary is selected 255 channels are accessible. If BCD is selected 99 channels are accessible.
3. *Software channel select.* If DIP switch SW1is set to 0 then it is possible to send a software command to the radio to select the channel.
4. *Front panel Push-wheel switches*. If this option is fitted the rear channel select port is internally wired to the Push-wheel switches however the rear channel select function is still in parallel with the Push-wheel. The rear select method should not be used in this case. There are 100 channels selectable from the front panel. The same rules apply to this channel select method as apply to the rear port described below. BCD Coding is selected using MXTOOLS.

The following rules apply.

(The assumptions of logic levels are base on factory default setup. The Active state is Low)

DIP1 switches have priority over channel change. If any of DIP1 switches are set to ON (logic low) the rear inputs and the software Channel command will be ignored.

If DIP1 switches are set to OFF (logic high) then both the software commands and the rear input port would select the channel. In this case the most recent event will take priority. For example, if the rear input port is set to CH10 and a software command arrives to send it to CH15, the radio will go to CH15. If the rear input port is now changed to CH11 the radio will switch to CH11.

If DIP switches are set to OFF and the radio is powered up, the channel selected on the rear port will be adopted.

If DIP1 switches and the rear port are both set to OFF (logic High), on power up, the radio will adopt the last software channel selected. This may be the software channel set at the factory if the user has not used the software channel select feature before.

Configure Alarms/M Lead

The MX800 has 3 open collector outputs. Two of these are assigned as alarm outputs and one (output 1) may be configured as either an alarm output or an M Lead output. If the output one is configured as an M Lead, this line is active when mute is open and CTCSS/DCS is decoded. These outputs are assigned in the Configuration screen of MXTOOLS.

Configure Digital I/O

The MX800 has 16 digital inputs and 8 general-purpose outputs. The inputs are +5V CMOS logic compatible and are buffered by a 10K resistor in series with each input. JMP19 on the Micro-Controller selects whether these inputs are internally pulled up or internally pulled low. The active state of the input is set up through MXTOOLS. Of the 16 inputs the 8 input port B inputs are allocated to the Channel Select function. Two of the input port A inputs (bit 0 and bit 1) are allocated to a power control function (see Table 5 Power Control Function Settings below), two (bit 2 RX and bit 3 TX) are allocated to CTCSS control and the other 4 are allocated as address bits for the MX800 network mode (software V2.8.1 and higher).

Bit 1	Bit 0	RF O/P Power
0	0	100%
0	1	50%
1	0	20%
1	1	10%

Table 5 Power Control Function Settings

An auxiliary voltage (either +5V or GND dependant upon the setting of JMP15) is available on CN3 pin one for wiring convenience.

The 8 general-purpose outputs are +5V CMOS logic compatible and are buffered by a series 1K resistors.

Options

T01 Programmable Channel Spacing

The MX800 receiver is available in five different channel spacing options. For applications in systems that require both 12.5kHz and 25kHz channel spacing option T01 allows channels to be programmed for either bandwidth. Switchable IF filters in the receiver and automatic 12.5kHz/25kHz gain compensation in the audio paths make the change in bandwidth transparent to the user.

This option must be specified at order placement. Once the switchable IF bandwidth receiver is fitted, the programmable channel spacing option is selected on the MXTOOLS Configuration screen (Hardware Settings tab) and each channel is programmed as either 12.5kHz/25kHz via the Channel Edit screen.

T02 Programmable CTCSS encoder/decoder

Provision is made in the MX800 to fit a CTCSS encoder/decoder. The decoder is non-predictive and any valid CTCSS tone can be decoded. Any standard TX CTCSS tone may be associated with the programmed decode tone through the Channel Edit screen in MXTOOLS. Multiple CTCSS tones are programmable for any channel providing "Community Repeater" functionality.

This option may be fitted at order placement or retro fitted subsequently.

T03 Programmable DCS/CTCSS encoder/decoder

Provision is made in the MX800 to fit a full duplex DCS encoder/decoder. There are 83 digital codes available. Any standard DCS code or CTCSS tone may be assigned to any of the transmit or receive channels through the Channel screen in MXTOOLS. Multiple CTCSS tones are programmable for any channel providing "Community Repeater" functionality.

The DCS encoding function provides continuous, repetitive digital word modulation to the transmitter. The decode function controls receiver muting to eliminate all calls that are not coded with the assigned DCS code.

This option may be fitted at order placement or retro fitted subsequently. The DCS PCB assembly is fitted in place of IC25 (MX805AP). Once the DCS option is fitted the "DCS option fitted" check box is ticked in the MXTOOLS Configuration screen and the encode and decode codes are programmed through the Channel Edit screen.

T04 Balanced and Isolated VF

Prefered option is T29

Standard VF connections to line are 600ohm 4-wire unbalanced. Option T04 may be fitted if transformer balanced and isolated VF inputs and outputs are required. A transformer PCB is fitted internally at the rear of the MX800. This PCB has a RJ45 connector (CN9), which protrudes through the rear panel when this option is fitted, and the balanced VF outputs are made available via this connector.

Note that theses connections are essentially in parallel with the standard VF connections on CN1. The VF lines on CN1 are still connected when option T04 is fitted and care should be taken that the TX VF line is not doubly terminated or that two VF sources are not presented to the transmitter.

Pin No	Function
1	600ohm balanced RX VF leg a
2	600ohm balanced RX VF leg b
3	600ohm balanced TX VF leg a
4	600ohm balanced TX VF leg b
5	NC
6	NC
7	NC
8	NC

Table 6 CN9 Connections

The RJ45 pins are numbered as shown in Figure 5 below.

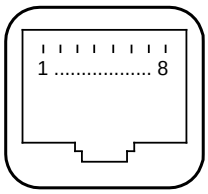


Figure 5 CN9 RJ45 Pin-out Detail (View from Rear of MX800)

T05 Balanced and Isolated VF plus E&M

Prefered option is T29

Option T05 provides the balanced and isolated VF I/O as per option T04 as well as isolated E (PTT) and M (Mute) leads.

Note *Jumpers referred to in the table below are those on this option PCB.*

The E lead is opto isolated and may be asserted by applying a DC voltage between 5V and 48V with any polarity between CN9 Pins 7&8 (JMP1 in position 2-3, JMP2 removed). Provision is also made to internally source the activation voltage (+12V DC) in which case the E lead is asserted by grounding CN9 Pin8 (JMP1 in position 1-2, JMP2 fitted.)

The M lead is relay isolated and the common and normally open contacts are brought out via CN9. If the internal +12V DC is being used as the activation voltage for the E lead (JMP1 in position 1-2) then the normally closed contact is also available at CN9. The relay contacts are rated at 500mA.

Pin No	Function
1	600ohm balanced RX VF leg a
2	600ohm balanced RX VF leg b
3	600ohm balanced TX VF leg a
4	600ohm balanced TX VF leg b
5	M Lead common
6	M Lead normally open
7	E Lead leg a/M lead normally closed
8	E Lead leg b

Table 7 CN9 Connections

The RJ45 pins are numbered as shown below.

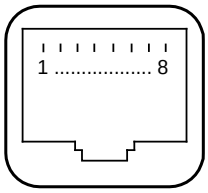


Figure 6 CN9 RJ45 Pin-out Detail (View from Rear of MX800)

T06 Simplex Changeover Relay

For simplex applications an internally mounted coaxial changeover relay can be provided. This mounts on the rear panel and the common port protrudes through the chassis providing the simplex antenna connection. The relay normally closed port is internally connected to the MX800 receiver and the normally open port is connected to the transmitter via the standard RX connector hole in the chassis (the RX connector is removed) using a special cable assembly. The relay also has control connections to the micro controller PCB.

Once the relay option is fitted the channels are programmed as simplex channels through the Channels Edit screen of MXTOOLS. Switches SW2/1 & SW2/2 on the micro controller are switched ON to delay the transmitter PTT (to allow the relay to changeover) and set the simplex operating mode respectively.

Figure 7 T06 Simplex Changeover Relay

T07 Turn Around Mixer

This option is not currently available. This option has the ability to take some of the RF signal from the exciter and convert it to a suitable frequency for injection into the receiver. The received RF signal level is user settable such it can used to test the performance and sensitivity of the receiver for the purpose of advanced automated self testing and diagnostics. Provides additional advanced B.I.T.E. (Built In Test Equipment) capability over that as provided as standard. Consult Spectra regarding your application.

T08 VF Delay

This option provides a 40mS delay to the received audio. When the option is fitted delayed audio is fed to the line and talkthrough paths but discriminator audio (output on CN1 Pin4) is undelayed.

This option is intended for two main applications. Firstly when the delay is fitted, the mute (squelch) "crash" characteristically heard when a mobile releases its PTT but the repeater tail continues, it is eliminated. Secondly systems (including trunking systems) which have mixed voice and data on a channel can delay the VF signal to line and air so that in the event that a data stream is detected (by the data controller) the VF to line and air can be disconnected for the duration of the data burst thus avoiding radio system user annoyance. Internal switches in the MX800 may be used to disconnect the audio under the control of the RX TALK line (CN1 Pin7) the sense of which may be inverted using JMP12 on the micro controller.

This option may be fitted at order placement or retro fitted subsequently. The Option PCB assembly is fitted above the Micro controller on four hex pillars. A 16-way ribbon connection is made from the Option PCB to SKK on the micro controller card. The links on the Option card are set as below. Once the delay option is fitted the "Delayed Audio Option" check box is ticked in the MXTOOLS Configuration *screen* (Hardware settings tab).

Note that this options PCB is also used for T09, CTCSS Suppression Upgrade Filter and T10, the Low Standby Current Mode and all three are independent and may be used separately or together. If the option PCB is ordered for one particular option it may or may not be populated for the other options.

JMP	Function/Description	Option Active	Option Disabled
JMP 1	Low standby current mode switched exciter power	Out	In
JMP 2	Low standby current mode switched receiver power	Out	In
JMP 3	300Hz Elliptic filter	1-2	2-3
JMP 4	RX audio delay	2-3	1-2

Table 8 Option PCB Link Settings

T09 300Hz Upgrade HPF Filter

This option provides upgraded CTCSS tone suppression on the RX VF. When this option is fitted the standard 300Hz filter is removed from circuit by changing the position of JMP5 on the micro controller to position 1-2.

This option may be fitted at order placement or retro fitted subsequently. The Option PCB assembly is fitted above the Micro controller on four hex pillars. A 16-way ribbon connection is made from the Option PCB to SKK on the micro controller card. The links on the Option card are set as below. This option is purely a hardware change and no configuration is required using MXTOOLS.

Note that this options PCB is also used for T08, VF Delay and T10, the Low Standby Current Mode and all three are independent and may be used separately or together. If the option PCB is ordered for one particular option it may or may not be populated for the other options.

JMP	Function/Description	Option Active	Option Disabled
JMP 1	Low standby current mode switched exciter power	Out	In
JMP 2	Low standby current mode switched receiver power	Out	In
JMP 3	300Hz Elliptic filter	1-2	2-3
JMP 4	RX audio delay	2-3	1-2

Table 9 Option PCB Link Settings

T10 Power Save Mode

For solar powered sites and other power critical applications the MX800 is capable of a Power Save (Low Standby Current) Mode. This option can be implemented in three stages. Stage one implementation replaces the micro controller linear voltage regulators with switching regulators. Response times are unaffected. Stage two involves removing power from the exciter when the radio is in standby mode. In this case RX responses times are unaffected. In stage three the RX power is cycled on and off at a user selectable duty cycle. Essentially the choice of mode of operation involves a compromise between response time and average current consumption. Current consumption of 250mA is achievable with a typical response time in the order of 1sec.

Condition	Description	Approx Average Current Drain mA
Standard	Standard MX800 (TX VCO on continuously)	525
Standard	Standard MX800 (TX VCO switched)	490
Stage 1a	Standard MX800 (TX VCO on continuously) option board fitted	475
Stage 1b	Standard MX800 (TX switched) option board	440

	fitted	
Stage 2	TX exciter inc TX VCO powered down	370
Stage 3 RX 100% duty	TX exciter inc TX VCO powered down RX module power duty cycled	370
Stage 3 RX 50% duty	TX exciter inc TX VCO powered down RX module power duty cycled	255*
Stage 3 RX 25% duty	TX exciter inc TX VCO powered down RX module power duty cycled	198*

*Average current calculation is based on RX off current drain of 140mA and RX on current drain of 370mA.

Table 10 Current Consumption Details

This option may be fitted at order placement or retro fitted subsequently. The Option PCB assembly is fitted above the Micro controller on four hex pillars. A 16-way ribbon connection is made from the Option PCB to SKK on the micro controller card. The links on the Option card are set as below. Once the power save option is fitted the "Power Save Option Board Installed" and "Power Save Exciter Module" check boxes are ticked in the MXTOOLS Configuration screen (Hardware settings tab). In addition three timers need to be set. "Idle Time to Power Save" is entered in seconds and defines how long the radio will wait following the most recent activity before reverting to standby mode. "RX Module On Time" and "RX Module OFF Time" define the duty cycle of the receiver module.

Note that this options Printed Circuit Board is also used for T08, VF Delay and T09, CTCSS Suppression Upgrade Filter and all three are independent and may be used separately or together. If the option PCB is ordered for one particular option it may or may not be populated for the other options. If the option is being retrofitted the two main 5 Volt 78M05 regulators on the Microcontroller board must be removed and subsequently replaced if de-installing.

JMP	Function/Description	Option Active	Option Disabled
JMP 1	Low standby current mode switched exciter power	Out	In
JMP 2	Low standby current mode switched receiver power	Out	In
JMP 3	300Hz Elliptic filter	1-2	2-3
JMP 4	RX audio delay	2-3	1-2

Table 11 Option PCB Link Settings

T11 Combined Options

This option combines the functions and features of T08, T09 and T10

T12 External Reference Oscillator Input

The MX800 receiver and transmitter modules have separate reference oscillators. In normal operation to achieve a low frequency transmitter modulator frequency response to DC, the MX800 normally uses a two-point

modulation method. For two-point modulation, the TX reference oscillator and the VCO are both modulated together and in phase. Option T12 provides for the TX reference frequency to be externally injected. An SMB connector is fitted to the exciter and an internal cable is provided from there to a chassis mount N Type connector into which the external reference frequency is injected. As two-point modulation is not possible with this configuration, the transmitter frequency response is only specified to 67Hz for this option.

The N Type connector will be required to be used for the RX I/P in which case the BNC becomes the external reference I/P.

A range of reference frequencies from 1MHz to 16MHz can be used with this option. With MXTOOLS, check your exact frequency can be programmed and accepted.

T13 Local Speaker, Mic Socket and Front Panel Mute

For applications needing a user interface at the base station the MX800 is available with the Local Control option. The full implementation is described in section 0 this section describes the part fitted under option T13.

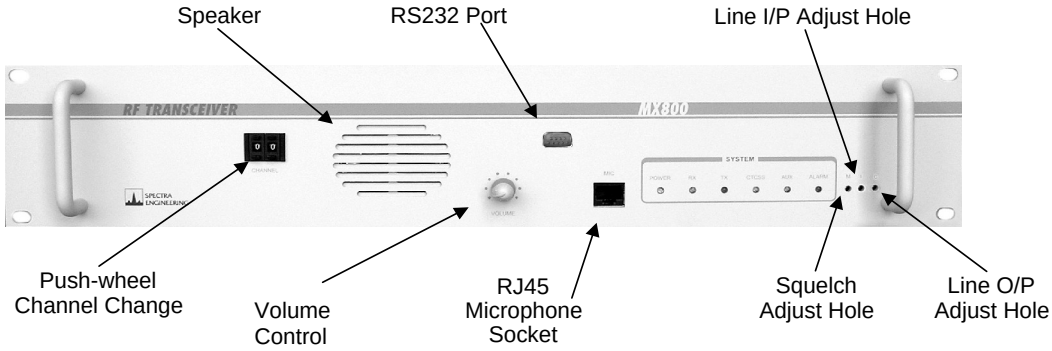


Figure 8 Front Panel with Speaker, Mic and Mute

Loudspeaker and Volume Control

A 1 Watt loudspeaker is provided to monitor 'on air' received audio as well as transmit audio from line. Volume control is provided by means of a volume pot or a 3-position toggle switch adjacent to the loudspeaker. This switch is biased in the centre position. To raise or lower the volume the switch is momentarily moved up or down respectively. For each switch closure the volume is incremented or decremented a fixed amount.

The speaker has a link selectable connection to a tone output from the micro controller. This may be used in conjunction with the appropriate software configuration to generate an alert tone to the user.

Microphone Socket

An RJ45 socket is provided for connection of a microphone. This socket is wired compatibly with the Motorola GM300 microphone.

Mute / Squelch Adjustment
Provision is made to optionally locate the squelch control potentiometer behind the front panel. A screwdriver hole is provided in the front panel to access this adjustment.

Pin No	Function	Comment
8	PB1	5V CMOS input
7	PB2	5V CMOS input
6	Hook/monitor	For quiet base
5	Mic ETH	
4	Mic VF in. High or low level	Set JMP22 IN for low gain dynamic Mic
3	Mic PTT.	Pulled to +5V via 10K
2	+5 volts out	Current limited via 220R
1	Low level muted RX VF	

Table 12 MX800 Mic Socket Pinout

The RJ45 pins are numbered as shown in Figure 3-4 below.

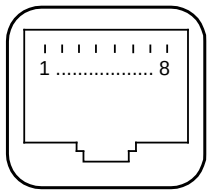


Figure 9 RJ45 socket viewed from front of MX800

T14 Local Channel Change

For applications needing a user interface at the base station the MX800 is available with the Local Control option. The full implementation is described in section 1.1.1.2, this section describes the part fitted under option T14.

Channel Change Control
Twin push wheel switches can be optionally fitted to the front panel to allow selection of the operating channel. When fitted this switch is wired to the channel select pins on SKF/E, the rear channel select port, and replaces the channel select function normally accessible on the rear digital I/O connector. 99 channels are selectable. Refer to section 2.2.2.3 for more details on alternative channel select methods.

T16/T17 1PPM Frequency Stability 12.5 kHz, N to X Bands

This option provides for 1PPM frequency stability for narrowband MX800s in the N to X bands. This frequency stability is specified from –30° C to +60° C. Option T16 and T17 are the same. 1PPM stability can additionally be used on any frequency band above 66 MHz but the DC-FM transmitter modulation feature is not fully specified below 400 MHz. Typically, this results in only some minor drop of the low freq response or ability to set up the Transmitter modulation balance.

T18 Extended Temperature Range Verification

The MX800 is optionally available in an extended operating temperature range version, extending the temperature range over –30° C to –10° C. Additional testing and operational verification is done in an environmental chamber at –30C for 24 Hours. An additional factory test report sheet is provided at his temperature. Frequency stability is specified at 2.5PPM for this option.

T19/26 Line Interface Board.

The MX800 T19 / T26 option board provides the radio base station with utmost flexibility in system design and capabilities, with an extensive range of new features.

Please consult Spectra, for the availability of these features or software upgrades. Not all features are currently available.

- 2Wire (VF Hybrid) or 4Wire Selection, Balanced Audio, Dual E+M,
- VF Delay (To replace option T08)
- Base Station Variable Tone Voting
- Base Station Stepped Tone Voting
- Status Tone Encoding And Decoding
- Five Tone Encoded / Decoder

- DTMF Decoder
- Remote Control Capabilities
- Fast CTCSS Decoder
- VF Line compensation for SINAD Voters
- Real-time Clock

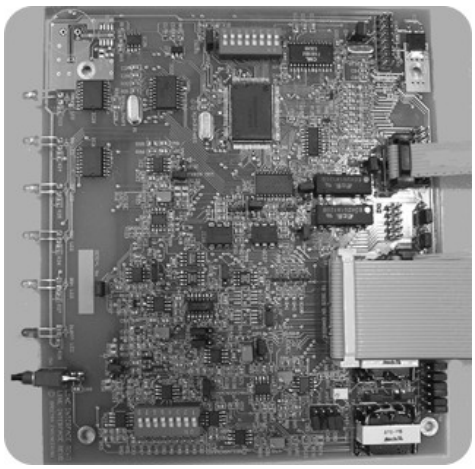


Figure 10 MX800 T19/T26Option Board

Due to ongoing development please refer to www.spectraeng.com.au for the latest information regarding this option.

Note *These are software selectable provided the correct option board is selected/used, and not all option can be used in conjunction with each other. Some parts many not be populated.*
Jumpers referred below are those on this option PCB.

Pin No	Function
11	M Lead
24	M Lead normally open

Table 13 CN3 Connections

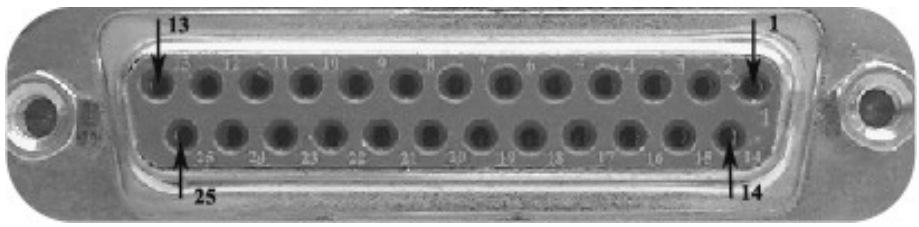


Figure 11 CN3 Pin-out Detail (View from Rear of MX800)

Pin No	Function
1	600ohm balanced RX VF leg a
2	600ohm balanced RX VF leg b
3	600ohm balanced TX VF leg a
4	600ohm balanced TX VF leg b
5	M Lead common
6	M Lead normally open
7	E Lead leg a/M lead normally closed
8	E Lead leg b

Table 14 CN9 Connections

The RJ45 pins are numbered as shown below.

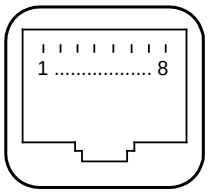


Figure 12 CN9 RJ45 Pin-out Detail (View from Rear of MX800)

JMP Number	Jumper description	Default Jumper Position For T19/T26
JMP1	Decoder select	1-2
JMP2	M1 Source jumper	N/F (Unlinked)
JMP3	M2 Source jumper	N/F (Unlinked)
JMP4	E2 Source jumper	N/F (Unlinked)
JMP5	E1 Source jumper	N/F (Unlinked)
JMP6	RX Line compensation IN/OUT	1-2
JMP7	RX Low pass filter IN/OUT	2-3
JMP8	RX Notch filter IN/OUT	1-2
JMP9	TX Notch filter IN/OUT	1-2
JMP10	2W/4W Selection	1-2 (4Wire mode)
JMP11	2W/4W Selection	1-2 (4Wire mode)
JMP12	2W/4W Selection	1-2 (4Wire mode)
JMP13	AGC IN/OUT	2-3
JMP14	High Pass Filter IN/OUT	2-3
JMP15	2W/4W Selection	1-2 (4Wire mode)
JMP15	2W/4W Selection	1-2 (4Wire mode)
JMP16	2W Isolation Balance	N/F (Unlinked)
JMP17	2W Isolation Balance	N/F (Unlinked)
JMP18	2W Isolation Balance	N/F (Unlinked)
JMP19	2W Isolation Balance	N/F (Unlinked)
JMP20	Tone Generation path	1-2
JMP21	CNVSS	Connected (CNVSS)
JMP22	2W/4W Selection	1-2 (4Wire mode)
JMP23	2W/4W Selection	1-2 (4Wire mode)
JMP24	4W Selection	Linked
JMP25	4W Selection	Linked

Table 15 T19/26 Factory Default Jumper Setting.

2Wire or 4Wire Selection, Balanced VF

Option T19 and T26 both provide the user to be able to select between 2 wire or 4 wire systems, they also both have balanced and isolated VF I/O as well as isolated E (PTT) and M (Mute) leads. The T19 has dual E&M leads, this provide a Qualified and Non-qualified M leads as well as E leads with subtones and with out subtones. The second E&M connection points are found on CN3 DB25 connector.

VF Delay

This option provides a 40mS delay to the received audio. When the option is fitted delayed audio is fed to the line and talkthrough paths but discriminator audio (output on CN1 Pin4) is undelayed.

This option is intended for two main applications. Firstly when the delay is fitted the mute "crash" characteristically heard when a mobile releases its PTT but the repeater tail continues, it is eliminated. Secondly systems (including trunking systems) which have mixed voice and data on a channel can delay the VF signal to line and air so that in the event that a data stream is detected (by the data controller) the VF to line and air can be disconnected for the duration of the data burst thus avoiding radio system user annoyance. Internal switches in the MX800 may be used to disconnect the audio under the control of the RX TALK line (CN1 Pin7) the sense of which may be inverted using JMP12 on the micro controller.

This option may be fitted at order placement or retro fitted subsequently. The Option PCB assembly is fitted above the Micro controller on four hex pillars. A 16-way ribbon connection is made from the Option PCB to SKK on the micro controller card. The links on the Option card are set as below. Once the delay option is fitted the "Delayed Audio Option" check box is ticked in the MXTOOLS Configuration screen (Hardware settings tab).

Variable & Stepped Tone Encoder

Variable tone voting is a method of conveying the received signal strength information to a central arbiter so that an informed decision can be made as to which base station will use its received audio.

There are two methods of this type of encoder, Variable tone that works by superimposing a sliding scale audio tone on the received audio at each site, and stepped tone that works by superimposing a fixed audio tones per decision block. This tone frequency being related to the received signal strength (RSSI). The tone is removed at the central site and the best audio is turned around for retransmission. This requires a VF connection between each base station and the central arbiter.

Prior to a tone being superimposed the receiver VF is notch filtered at the tone frequency.A Second PTT function designed for mobile voting systems transmits carrier with no modulation (including no CTCSS) to allow mobiles to vote without lifting the mute in the mobile.

Voting Law

The table below shows the default voting decisions points programmed into the MX800 T19 / T26 option board. These are the corresponding signal points where by under control of the microprocessor to generates the appropriate audio tone.

Level 0 refers to the signal level when the mute opens and is less than Level 1. The option board incorporates a signal noise measurement circuit that needs to be calibrated for the board to perform optimally.

RF Signal Decision Points	Level (uV)	Frequency (Hz)
Squelch closed	N / A	2710
Level 0 signal	> 0	2732
Level 1 signal	> 0.6	2792
Level 2 signal	> 1.0	2856
Level 3 signal	> 2.0	2913
Level 4 signal	> 5.0	2973

Table 16 Signal level decistion level/points and coresponding tones.Status Tone Encoding And Decoding

This power full option board allow the use to be able to monitor the status of there MX800. This option works by superimposing fixed audio tones per status to line. Providing status on mute open or closed. This signal then can be send down a 2 or 4 wire line system. The decoder then processes the status tones and applies the various functions as need. I.e. Programmable PTT tones, PTT ON & PTT OFF.

RX mute status tone encoder provides tone either when mute is open or when mute is closed depending upon system requirement. Speech or noise components on the turn frequency can optionally be notched out.

Five Tone Encoded / Decoder

The T19 option board is equipped for 5 or 6 tones Selcall operation according to CCIR, EEA, ZVEI 1, ZVEI 2 and other standards. This provides a flexible predictive or non-predictive all-tone decoding, plus able to transpond all 5/6 tones and all-system group-call and ANI operations. The Selcall encoder / decoder IC is under the control of the microprocessor.

This option is not currently available. Due to ongoing development please refer to www.spectraeng.com.au for the latest information regarding this option.

DTMF Decoder

This option is not currently available. Due to ongoing development please refer to www.spectraeng.com.au for the latest information regarding this option.

Remote Control Capabilities

This option is not currently available. Due to ongoing development please refer to www.spectraeng.com.au for the latest information regarding this option.

Fast CTCSS Decoder

This option is not currently available. Due to ongoing development please refer to www.spectraeng.com.au for the latest information regarding this option.

T29 Balanced and Isolated VF plus E&M

Option T29 provides the balanced and isolated VF I/O as well as isolated E (PTT) and M (Mute) leads, as per option T05. The option has been design to be compatible with more standard interface connections.

Note *Jumpers referred to in the table below are those on this option PCB.*

The E lead is opto isolated and may be asserted by applying a DC voltage between 5V and 48V with any polarity between CN9 Pins 1&2 (JMP1 in position 2-3).

Provision is also made to internally source the activation voltage (+12V DC) in which case the E lead is asserted by grounding CN9 Pin2 (JMP1 in position 1-2)

The M lead is relay isolated and the common and normally open contacts are brought out via CN9. If the internal +12V DC is being used as the activation voltage for the E lead (JMP3 in position 1-2) then the normally closed contact is also available at CN9 pin 8. The relay contacts are rated at 500mA.

Pin No T29	Function
5	600ohm balanced RX VF leg a
4	600ohm balanced RX VF leg b
6	600ohm balanced TX VF leg a
3	600ohm balanced TX VF leg b
7	M Lead common
8	M Lead normally open
2	E Lead leg a/M lead normally closed
1	E Lead leg b

Table 17 T29 RJ45 Pin outs.

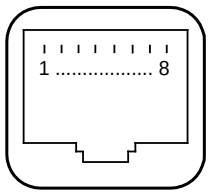


Figure 13 CN9 RJ45 Pin-out Detail (View from Rear of MX800)

JMP	Factory Default setting
1	Position 2-3
2	Not fitted
3	Position 2-3
4	Not fitted

Table 18 T29 Factory Default Jumper Setting.

Appendices

MX800 Interface Connections

The user connections to the MX800 are all made via the rear panel where the following connectors are located.

No	Conn Type	Function	Description
CN1	DB15-F	Line I/O	Provides the necessary analog receiver and transmitter interface for system interfacing.
CN2	DB9-F	Monitor port	Provision for monitoring status certain internal signals
CN3	DB25-F	Parallel I/O	Provides two 8 bit input ports, where one is used as the parallel BCD channel select. Also one 8-bit output port.
CN4	DB9-M	RS-232 serial port	9600 Baud serial port for frequency programming, channel selection and alarm and status monitoring.
CN5	3 PIN	DC Power input	13.8 Volt DC power input. Also +28 Volt input on spare pin.
CN6	N TYPE	Simplex relay out or N type RX input	Location for internal simplex relay. The antenna for RX / TX connects to this point. Alternatively a N-Type connector can be used for the input to the receiver for full duplex operation
CN7	BNC	RX input	Standard BNC connector for the input to the receiver for full duplex operation.
CN8	N TYPE	TX output	The RF power output from the transmitter for full duplex operation.
CN9	RJ45	Optional Bal line I/O	Optional balanced and isolated Line TX and RX VF and isolated E & M signals

Table 19 MX800 Interface Connectors

CN1 DB15 Female Line I/O Connector

This connector provides the primary interface to the transceiver. Pin connection and function details are shown below.

Pin no	Function
1	O/C ALARM OUTPUT #2. Open collector output sinks current to earth when an alarm condition occurs. The function of the alarm and the trip points as appropriate are programmable via the utility program. Selectable Alarm functions are Low Fwd Power, High Refl Power, Low Supply Volts, High Supply Volts, High PA Temp, TX Unlocked and RX Unlocked.
2	TX VF LOOP BACK. When this input is active the line TX audio path is looped to the line RX audio output. The polarity is selectable via the internal jumper JMP9. If this function is not required then remove jumper JMP9 or place it in position 1&2. An internal trimmer pot RV7 sets the loop back gain / loss level. CTCSS O/P. This function is enabled Via JMP26. This then disable the TX VF LOOP BACK function. The Receivers demodulated filtered RX Subtone audio output from op-amp, Fixed level. AC coupled.
3	RECEIVER AUDIO 5Ω. Low impedance differential audio output from op-amp.
4	RX DISCRIMINATOR. The receiver discriminator audio output is buffered, unfiltered and DC coupled to this point. Output impedance is low.
5	O/C ALARM OUTPUT #3. Open collector output sinks current to earth when an active condition occurs. The function of the alarm and the trip points as appropriate are programmable via the utility program. Selectable Alarm functions are Low Fwd Power, High Refl Power, Low Supply Volts, High Supply Volts, High PA Temp, TX Unlocked and RX Unlocked.
6	O/C ALARM OUTPUT #1. ./M-lead. This output is configurable via MXTOOLS as either an M-lead or a third alarm output. Open collector output sinks current to earth when an alarm condition occurs. The function of the alarm and the trip points as appropriate are programmable via the utility program. Selectable Alarm functions are Low Fwd Power, High Refl Power, Low Supply Volts, High Supply Volts, High PA Temp, TX Unlocked and RX Unlocked.
7	RX TALK. This control line enables or disables RX VF to line and TTR VF. The polarity is selectable via the internal jumper JMP12. If this function is not required then remove jumper JMP12 or place it in position 1&2.
8	REPEATER ENABLE. On/off mode control of internal repeater function. The polarity is selectable via the internal jumper JMP14. If this function is not required then remove jumper JMP14 or place it in position 1&2.
9	TRANSMIT AUDIO INPUT 600Ω. Transmitter audio input to op-amps etc. Nominal line input level is -10dBm. Can handle levels between -15dBm and +6dBm. Unbalanced input with common return to analog Earth.
10	ANALOG EARTH. General analog earth common for VF input and output.
11	TX TALK. Enables or disables TX VF from line as well as TTR VF. The polarity is selectable via the internal jumper JMP18. If this function is not required then remove jumper JMP18 or place it in position 1&2.

12	TX PTT IN. (E-LEAD). The standard PTT input is active low and may be driven from standard +5V logic outputs or open collector
13	TX DC-FM INPUT OR WIDE BAND INPUT. Select the internal jumper JMP8 to configure this input as either the *DC-FM input* or *Wide Band input*. Remove jumper if not used. *DC-FM input (JMP8 in position 1-2)* 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 peak deviation and Bessel filtered -3dB @ 3400Hz for minimum group delay distortion. Input impedance is >10KΩ. Input sensitivity is nominally 1Vp-p but depends upon RV2 adjustment. If this input is not used then jumper # JMP8 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. Avoid the use of ribbon cables longer than 30-50cm as this may result in excess coupling or crosstalk. *WIDEBAND input: (JMP8 in position 2-3)* Wide band audio or data may be connected to this point. WARNING: In order to conform to transmitter bandwidth emissions limits, the signal MUST be pre-filtered and level controlled, failure to do this WILL result in non-compliance of the TX emission spectrum. This input mode is not normally used except in special cases. CTCSS *Input: (JMP27 in positions 1-2)* TX Subtone audio may be injected into this connection point. Input sensitivity is Fixed at 1Vp-p. AC coupled
14	RX MUTE / SQUELCH MONITOR. The RF mute status may be monitored by reading this voltage. +5volt logic signal indicates mute status. This output is not CTCSS dependent. Output impedance approx 100Ω. The polarity is selectable via the internal jumper JMP17.
15	RECEIVER AUDIO 600Ω. Receiver audio output from op-amp. Default nominal line level is set to -10dBm. Unbalanced output with common return to analog Earth.

Table 20 CN1 Connections

CN2 DB9 Female Monitor Connector

This port provides monitor and test functions for the MX800. It may be optionally located on the front panel of the MX800. The functions of the pins are described below.

Pin No	Function
1	EARTH. General earth common for VF input and output.
2	RX RSSI OUTPUT. 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.
3	EXTERNAL PTT INPUT OR MONITOR POINT. Input or output. Wired in parallel with the normal PTT via a 10K isolating resistor This input can override the normal PTT input on the DB15. Refer CCT.
4	TX FORWARD POWER. The voltage from the forward power directional coupler in the Power Amplifier goes directly to this pin via a buffer. The voltage should be about 3-4 Volts for 50 Watts.
5	+12 VOLTS OUTPUT. +12 Volt output to power small external devices or interfaces. Max load 500mA.
6	TX REFLECTED POWER. The voltage from the reflected power directional coupler in the Power Amplifier goes directly to this pin via a buffer. For a 50Ω terminated PA the voltage should be less than 200mV
7	MUTED RX VF. Monitor point and buffered output from the muted RX VF section.
8	FINAL TX VF MONITOR. Monitor point for buffered audio fed to TX VCO input.
9	TEST TX VF INJECT. 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 distortion. Input impedance is >10KΩ AC coupled. If this input is not used then 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.

Table 21 CN2 Connections

CN3 DB25 Female 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 up/down resistor at each input so as to default the input value to that set by JMP19. Each logic output is protected by a 1K-Ohm series resistor from the output of the logic chip.

Pin No	Function
13	DIGITAL EARTH or +5VDC output. JMP15 selectable.
25	INPUT PORT A. 8-bit Logic Input bit 0. (Power control bit 0)
12	INPUT PORT A. 8-bit Logic Input bit 1. (Power control bit 1)
24	INPUT PORT A. 8-bit Logic Input bit 2. (RX CTCSS control)
11	INPUT PORT A. 8-bit Logic Input bit 3. (TX CTCSS control)
23	INPUT PORT A. 8-bit Logic Input bit 4. (N/W address bit 0)
10	INPUT PORT A. 8-bit Logic Input bit 5. (N/W address bit 1)
22	INPUT PORT A. 8-bit Logic Input bit 6. (N/W address bit 2)
9	INPUT PORT A. 8-bit Logic Input bit 7. (N/W address bit 3)
21	INPUT PORT B. BCD Channel Select Units bit 0.
8	INPUT PORT B. BCD Channel Select Units bit 1.
20	INPUT PORT B. BCD Channel Select Units bit 2.
7	INPUT PORT B. BCD Channel Select Units bit 3.
19	INPUT PORT B. BCD Channel Select Tens bit 0.
6	INPUT PORT B. BCD Channel Select Tens bit 1.
18	INPUT PORT B. BCD Channel Select Tens bit 2.
5	INPUT PORT B. BCD Channel Select Tens bit 3.
17	OUTPUT PORT C. 8-bit Logic Output bit 7.
4	OUTPUT PORT C. 8-bit Logic Output bit 6.
16	OUTPUT PORT C. 8-bit Logic Output bit 5.
3	OUTPUT PORT C. 8-bit Logic Output bit 4.
15	OUTPUT PORT C. 8-bit Logic Output bit 3.
2	OUTPUT PORT C. 8-bit Logic Output bit 2.
14	OUTPUT PORT C. 8-bit Logic Output bit 1.
1	OUTPUT PORT C. 8-bit Logic Output bit 0.

Table 22 CN3 Connections

Note *When the front panel channel select option is fitted, input port should not be used from the external connector CN3 as it is wired to the thumbwheel switch.*

CN4 DB9 Male RS232 Connector

RS232 serial port to the MX800. It may be optionally located on the front panel of the MX800. Only 3 wires are required for the MX800 TXD, RXD and ground. The function of TXD and RXD pins can be interchanged by changing jumpers JMP10 and JMP11. Table 23 CN4 Connector Jumpers below illustrates this.

Name	Function	JMP 10/11	
	(Referred to MX800)	2-3	1-2
		CN4 Pin no	CN4 pin no
TD	Transmitted Data	3	2
RD	Received Data	2	3
SG	Signal Ground	5	5

Table 23 CN4 Connector Jumpers

Note *Both JMP10 and JMP11 must be set to the same positions. In position 2-3 the radio will require a serial cable with the TXD and RXD lines cross-connected. In position 1-2 a one to one cable is required.*

CN6 Simplex Relay/External Reference

This is an N type connector, which acts as the RF I/O port for simplex operation. Optionally the RX input for duplex operation may use this port instead of the BNC port or if an external reference is required this port can be used.

CN7 RX Input

This is a BNC connector used as the RX RF input.

CN8 TX Output

This is an N type connector used as the TX RF power output.

CN9 RJ45

This connector may optionally be fitted. The function depends upon which option board is fitted. A standard option is the isolated line I/O and this connector is used for this function when this option is fitted. See Options section for connection details.

A rectangular knock out section in the chassis provides for mounting of the connector should it be required.

CN5 DC Power Input

DC power is connected to the transceiver through this connector. The transceiver is fitted with a 3-pin male connector. For 50W transceivers pins 2 and 3 are used for the 12V DC pin 1 is unused. The power lead to the transceiver should be made from a gauge of wire suitable to ensure less than 0.5V drop at 10A for the required length of the lead.

PIN No	Function
1	Unused
2	Ground
3	+ 13.8VDC

Table 24 CN5 DC Power Input Connections

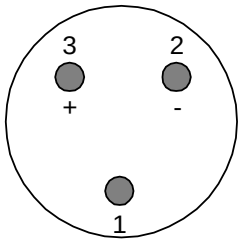


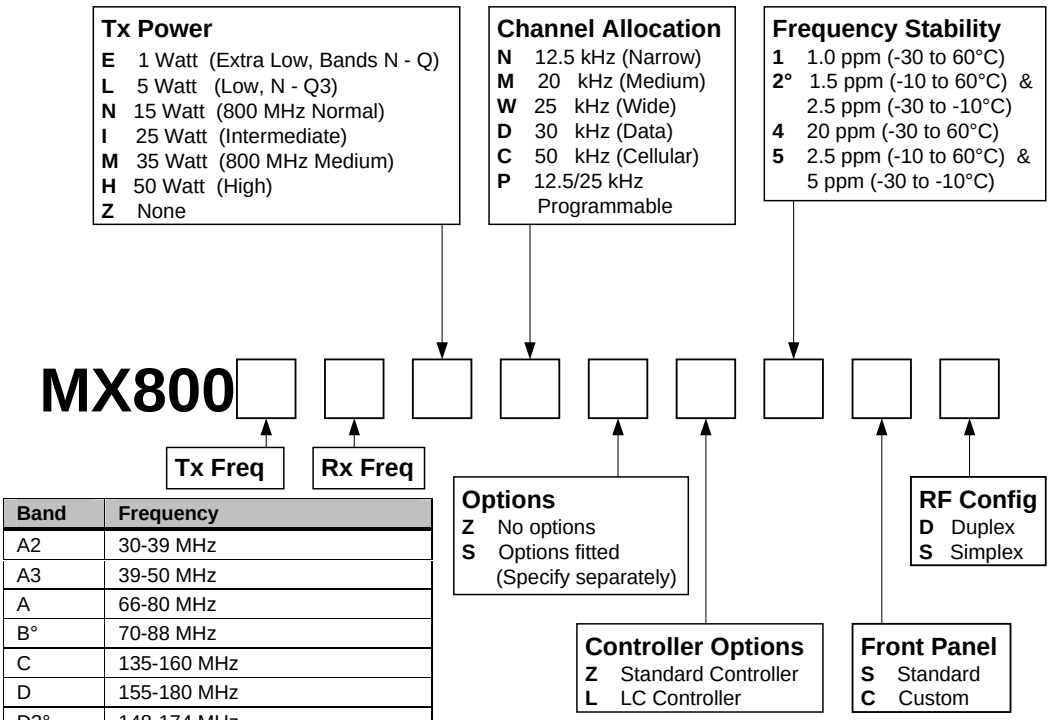
Figure 14 CN5 DC Input (View from rear of MX800)

Operating Frequency Bands

The MX800 is available in a number of models, which cover the range of operating frequency bands. As the transmitters and receivers are functionally independent the radios may be cross-banded if required. Refer to the Configuration guide for details of the band breakdown.

MX800 Model Number Configuration Guide

The MX800 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
A2	30-39 MHz
A3	39-50 MHz
A	66-80 MHz
B°	70-88 MHz
C	135-160 MHz
D	155-180 MHz
D3°	148-174 MHz
E	177-207 MHz
E2	177-185 MHz
F	195-225 MHz
G	220-250 MHz
H	245-275 MHz
I	270-300 MHz
J	295-325 MHz
K	320-350 MHz
L	345-375 MHz
M	370-400 MHz
N	395-430 MHz
N2°	400-435 MHz
O	425-460 MHz
O2	435-470 MHz
P	455-490 MHz
P2°	450-485 MHz
P3	475-495MHz
Q°	485-520 MHz
Q2	500-532 MHz
Q3	485-505 MHz

Band	Frequency
R	805-825 MHz
R2	746-764 MHz
R3	776-794 MHz
S	824-849 MHz
T	850-870 MHz
U	872-905 MHz
V	890-915 MHz
V2	900-925 MHz
W	917-950 MHz
X	925-960 MHz
Z	None

Notes:
1. Band E, L2, R3, Q2 receive only
2. Band E2, R2, V2 transmit only
3. ^{0} Indicates preferred band
4. Band A2, A3: 4 MHz Rx VCO Sw BW

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

Figure 15 Model Number Configuration Guide

MX800 System Applications

Comprehensive standard features along with a wide range of options and accessories available to it mean that the MX800 is capable of being used in many different applications. The most common of which are mentioned below together with notes where applicable on the relevant aspect of the MX800.

Figure 16 MX800 Setup in system rack

Conventional base station/repeater

Upper tier RF performance figures make the MX800 an excellent choice for a conventional base station or repeater. The PA is continuously rated and receiver figure of merit parameters such a sensitivity, intermodulation and selectivity are all of a high standard. Independently adjustable PTT and

CTCSS tails mean that the mute crash can be eliminated in mobiles when base transmit CTCSS is used.

A 40ms RX audio delay option (T08) similarly facilitates the elimination of the mute crash in the base station side.

As standard feature when the CTCSS encode/decode option is selected is multiple tone groups. In excess of 25 tones can be selected as valid CTCSS tones on a shared RF channel. Provision is made in the programming software to enter tone pairs for each group without restriction on how the tones are selected.

Many other attributes of the MX800 and its options are useful in conventional base/repeater systems. For example:-

- Programmable channel bandwidth
- DCS / Digital Private Line
- Range of front panel functions available
- Optional two wire four wire operation
- Tone PTT with programmable PTT tone
- Optional balanced and isolated VF I/O and signaling lines

Link transceiver

In the UHF bands (400 to 520 MHz) the MX800 is available in 1W and 50W. The 1W version being intended for link transceiver application. Transmit and receive

audio is conveniently brought out to the D15 connector on the rear of the radio along with the mute and PTT signals. In addition, provision is made to inject an Analog CTCSS tone into the transmit leg of the link and a 300Hz low pass filtered CTCSS signal is available at the RX leg of the link to recover the tone. Hence the Analog CTCSS tone can be transferred (or cross banded) from one MX800 to another. On an RF path with good signal to noise ratio, this enables CTCSS synchronization across the link in the situation where multiple tone group operate at two different sites. Spectra Engineering plans to upgrade this function with a digital 4 bit interface such that the operating CTCSS group is decoded at the repeater and re-encoded or cross encoded across the link, and the process repeated in reverse at the remote end.

Data transceiver

The MX800 transmit audio path is user configurable to a very large degree. TX modulation signals can be injected with or without processing depending upon the individual application. The transmitter low pass filter (the deviation limiter which sets the modulation bandwidth and ensures compliance with regulatory requirements) is a Bessel filter with linear phase characteristics. Fast transmitter key-up time and mute action mean reduced signalling turn around overheads for data messages and better throughput especially in a Simplex system with predominantly short messages.

Paging transmitter

Due to the two point modulation method employed in the MX800, the transmit modulation frequency response can go down to DC as correctly required for POCSAG or other FSK based modulation systems. In addition it has a DC coupled FM modulator input biased to a voltage of 2.5 volts for carrier frequency Fo. A square wave input signal of 0 to 5V injected on this point drives the modulator to the positive and negative extremes of the deviation limiter. In this case set to +/- 4.5kHz. This means that it can transmit typical POCSAG paging signals. The modulation rise time is controlled by the frequency response of the transmit audio path low pass filter and is suitable for data rates of up to 2400 baud.

Trunking Base Station

The MX800 is widely used as a trunking base station. A one hundred percent continuously rated transmitter is vital in the high duty cycle environment of a trunking systems. MPT 1327 control channels are permanently keyed up. Optionally the FSK signalling of MPT systems can be injected flat into an non pre-emphasized input and received on an non de-emphasized output which allows the signalling to go flat to air. As a compact two RU height enclosure the MX800 permits a high channel density for a given rack height.

LTR trunking systems make use of a digital sub audible signalling scheme. Once again the low frequency modulation capabilities (down to DC) of MX800 are vital in ensuring that the signalling takes place and a low bit error rate. A marginal system will result if the Transmitter modulation response can not go below 10Hz.

Systems base

Typical small systems environments. Once again the user interface presented at the rear of the radio and the software programmable functions through MXTOOLS give systems designers and large degree of control over the base station.

In a system, which operates in one RF band, it is particularly convenient and cost-effective if all base stations can be made and programmed identically. This reduces the number of spare base stations required to maintain the system. MX800 supports this mode of operation in as much as the operating characteristics of up to 255 channels can be pre-programmed in all of the base stations, and insertion of an on-site channel selector and configuration plug selects the particular operating parameters for that base station in that location. Spectra will introduce additional features in this area.

Repeater with Morse ID

A programmable built in Morse ID encoder makes it convenient to use the MX800 as a UHF CB repeater, Amateur repeater or auto identified repeater.

Simplex base station

Option T06 for the MX800 is a coaxial changeover relay. In a Simplex system with a single antenna and common transmit and receive frequencies

This can be used for connection of the transmitter and or receiver to the antenna. Provision is made in the programming to introduce a 50ms delay on transmit to allow the relay to changeover prior to RF ramp up.

Duplicated base station

The development of this Automatic Changeover Unit to facilitate duplicated base station operation is in progress.

This option is not currently available. Due to ongoing development please refer to www.spectraeng.com.au for the latest information regarding this option.

Power Save base station

For solar powered sites and other power critical applications the MX800 is capable of a Power Save (Low Standby Current) Mode. This option can be implemented in three stages. Stage one implementation replaces the micro controller linear voltage regulators with switching regulators. Response times are unaffected. Stage two involves removing power from the exciter when the radio is in standby mode. In this case RX responses times are unaffected. In stage three the RX power is cycled on and off at a user selectable duty cycle. Essentially the choice of mode of operation involves a compromise between

response time and average current consumption. Current consumption of 250mA is achievable with a typical response time in the order of 1sec.

Tone key base station

T19/T26 is a new Spectra Engineering development, which incorporates a number of features and functions, of which are covered in section 3.18

Voting base station

As noted in section 0 the MX800 with option to T19 can provide a Variable tone encoder. This encoder is compatible with a commonly used Variable tone-voting arbitrator.

MX800 can also be used with a SINAD voting arbitrator. Mute status of the receiver can optionally be signalled to the voting arbitrator via tone or through DC key E & M signalling.

Spectra engineering has current plans to implement the base station component of a race voting system using a Central arbiter.

Simulcast base station

Precise control of transmitter RF frequency is essential in simulcasts systems. Option T12 provides an external TX reference oscillator input for injection of highly stable oscillator. Almost any frequency may be injected.

In addition, each transmitter channel frequency can be offset individually by small amounts if the internal reference frequency is used. The 1PPM frequency Stability option is specified for a minimum of 8PPM adjustment. Take care if too much offset is used as this may effect the modulation symmetry. The use of this feature and a low frequency carrier dithering has proven to eliminate the previous requirements of extremely high stability reference frequency inputs.

The MX800 has been widely installed for the use in simulcast systems. These DSP based systems provide automatic compensation for changes in modulation delay characteristics.

