XetaWave

Xeta9

User Manual

Spread Spectrum Wireless Data Transceiver

Licensed Spectrum Wireless Data Transceiver

User Manual

Installation Guide

Models: Xeta9m, Xeta9-SB, Xeta9x-S (Emancipator)

Contents

Warranty

XetaWave LLC warrants your XetaWave wireless data transceiver against defects in materials and manufacturing for a period of three years from the date of purchase. In the event of a product failure due to materials or workmanship, XetaWave will, at its discretion, repair or replace the product.

In no event will XetaWave LLC, its suppliers or its licensors, be liable for any damages arising from the use of or the inability to use this product. This includes business interruption, loss of business information, or other loss which may arise from the use of this product. XetaWave LLC transceivers should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. XetaWave LLC accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the XetaWave transceiver, or for the failure of such transceiver to transmit or receive such data.

Warranty policy may not apply:

1) If product repair, adjustments, or parts replacements is required due to accident, neglect or unusual physical, electrical or electromagnetic stress.
2) If product is used outside of XetaWave specifications.
3) If product has been modified, repaired or altered by Customer unless XetaWave specifically authorized such alterations in each instance in writing.

The warranty period begins from the date of shipment and is defined per the standard warranty policy stated above.

Information in this document is subject to change without notice. The information contained in this document is proprietary and confidential to XetaWave LLC. This manual is for use by purchasers and other authorized users of the XetaWave wireless data transceiver only.

This product is licensed by the United States. Diversion contrary to U.S. law is prohibited. Shipment or re-export of this product outside of the United States may require authorization by the U.S. Bureau of Export Administration. Please contact XetaWave LLC for assistance and further information.

Regulatory and Compliance

UL

UL notification: This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D OR non-hazardous locations only.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.

WARNING – EXPLOSION HAZARD - Substitution of components may impair suitability for Class I, Division 2.

Input power shall be derived from a single Class 2 power source or equivalent.

The maximum operating temperature of the devices while subjected to the temperature test at a 85°C surrounding air temperature is in accordance with the temperature class of the table below:

Model	T-code
Xeta9x9-E, Xeta9-E, Xeta9x3-E, Xeta1-E, Xeta1x1-E, Xeta2-E, Xeta2x1-E, Xeta2x2-E, Xeta3-E, Xeta3x1-E, Xeta3x2-E, Xeta3x3-E, Xeta4-E, Xeta4x1-E, Xeta4x2-E, Xeta4x3-E, Xeta4x4-E, Xeta9-E, Xeta9x1-E, Xeta9x2-E, Xeta9x4-E.	T3C
Xeta9m-R, Xeta9m-T, Xeta9-SB, Xeta9m-R4V, Xeta9m-T4V	T4A
Xeta3m-R, Xeta1m-R, Xeta1m-T, Xeta2m-R, Xeta2m-T, Xeta3m-T, Xeta4m-T, Xeta4m-R	T5

To maintain the unit within the temperature class listed above the transmit and receive duty cycles must be set per the directions and table below. TX packet size must be **less than or equal to** the value shown. Rx packet size must be **greater than or equal to** the value shown.

Model Number	**Tx Packet Size <=**	**Rx Packet Size >=**	**Approximate Duty Cycle (%)**
Xeta1-E	1024	64	66.0
Xeta1m-R	64	64	36.7
Xeta1m-T	64	64	36.7
Xeta1x1-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5

Xeta2-E	1024	64	66.0
Xeta2m-R	64	64	36.7
Xeta2m-T	64	64	36.7
Xeta2x1-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta2x2-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta3-E	1024	64	66.0
Xeta3m-R	64	64	36.7
Xeta3m-T	64	64	36.7
Xeta3x1-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta3x2-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta3x3-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta4-E	1024	64	66.0
Xeta4m-R	64	64	36.7
Xeta4m-T	64	64	36.7

Xeta4x1-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta4x2-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta4x3-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta4x4-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta9-E, 4 Watts	100	64	53.5
Xeta9-E, 1 Watt	1024	1024	50.0
Xeta9m-R, 1 Watt MAS	250	64	39.0
Xeta9m-R, 1 Watt ISM	150	64	39.0
Xeta9m-R4V, 1 Watt ISM	600	64	83.8
Xeta9m-T4V, 1 Watt ISM	600	64	83.8
Xeta9m-T, 1 Watt MAS	250	64	62.4
Xeta9m-T, 1 Watt ISM	150	64	39.0
Xeta9-SB, 1 Watt ISM	200	64	66.0
Xeta9x-SB, 1 Watt ISM	200	64	66.0
Xeta9x1-E			
Radio 1	200	64	66.0

Radio 2	1024	128	85.5
Xeta9x2-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta9x3-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta9x4-E			
Radio 1	200	64	66.0
Radio 2	1024	128	85.5
Xeta9x9-E			
Radio 1, 4 Watts	100	64	53.5
Radio 2, 1 Watt	1024	64	91.0
Xeta9x9-E			
Radio 1, 1 Watt	1024	64	91.0
Radio 2, 1 Watt	1024	64	91.0

FCC and IC

This device complies with Title 47 CFR § Parts 1, 15, 101 of the federal code along with Industry Canada: RSS-102, Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands) and Safety Code 6 of Health Canada.

Specifically, 47CFR § 1.1310, Table 1, Limits for General Population/Uncontrolled Exposure and RSS-102, Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands) Table 4.2 RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment).

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.

This device must be operated as supplied by XetaWave LLC. Any changes or modifications made to the device without the express written approval of XetaWave LLC may void the user's authority to operate the device, pose violations and liabilities.

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.

Cet appareil conforme aux standards permit exempté RSS d'Industrie Canada. L'opération de cet appareil est sujet aux deux conditions suivantes. (1) Cet appareil ne peut pas provoquer des parasites ou des interférences et (2) cet appareil doit accepter toute interférence, incluant l'interférence qui peut causer l'opération non désirer de cet appareil.

Caution

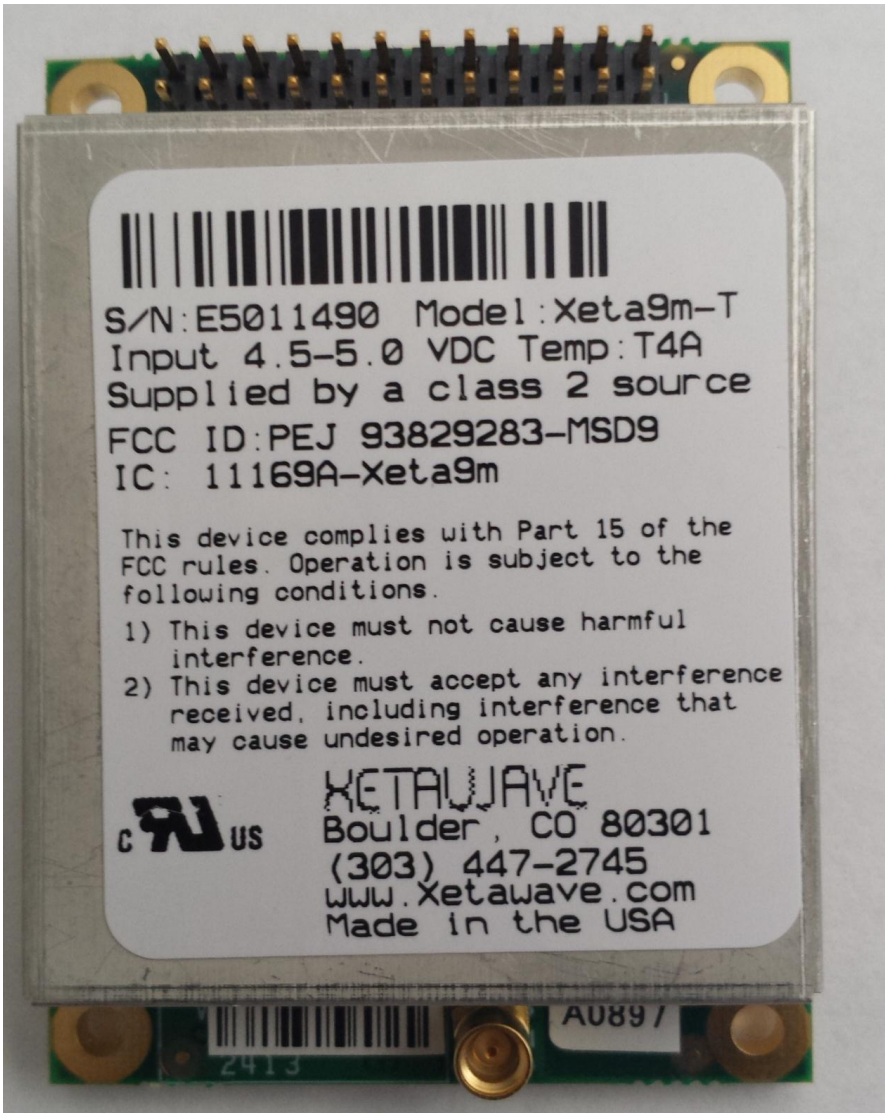
The model number XETA9 has a maximum transmitted output power of 4000 mW when used in the 928-960MHz band and 1000mW when used in the 902-928MHz band. At worst case, the transmit antenna shall be kept at least 34 and 17 cm respectively for MAS/ MCS and ISM bands, from psychical space where humans may exist. Additional details may be found in the "RF Exposure Calculations" section.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Title 47 CFR § Part 15 and ICES-003. These limits are designed to provide reasonable protection against harmful energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1) Reorient or relocate the devices and/or antennas.
2) Increase the separation between the equipment and the receiver.

3) Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
4) Consult the dealer or an experienced RF/radio/Electronics professional for help.

Whenever any XetaWave LLC module is placed inside an enclosure, a label must be placed on the outside of that enclosure which includes the module's FCC ID and IC ID.



WARNING

These radio systems shall be installed by a RF/radio professional familiar with the applicable rules. Installation of all antennas shall be performed in a manner that will provide at least the MPE Distance from the direction of maximum radiation, to any physical space where humans may exist, and consistent with the settings in the applicable antenna installation compliance section.

RF Exposure

FCC ID: PEJ-93829283-XETA9

IC ID: 11169A-XETA9

It is the responsibility of the licensee or user to guarantee compliance with the appropriate MPE regulations when operating this device in a way other than described herein. The installer of this equipment must ensure the antenna is located or oriented such that it does not emit an RF field in excess guidelines as posted in the Canadian RSS-102/Safety Code 6 of Health Canada, 47 CFR Bulletin 65/47CFR § 1.1310 of the Federal Communications Commission, or the Council of European Union as appropriate. People should not be near the antenna when the radio link is operating as general practice and maintain a safe distance as calculated below.

Note: Industry Canada and the US FCC use the same RF power density level for their limits, but express them in different units. The US FCC/OSHA/ANSI use milliwatts per square centimeter (mW/cm^2) and Industry Canada uses Watts per square meter (W/m^2).

$$W/m^2 = 10(mW/cm^2) \quad \text{eq. 1}$$

The following calculations are based off of the Maximum Permissible Exposure requirements as outlined by the FCC and IC. The MPE (Maximum Permissible Exposure) distance is calculated based on the limits for a General Population/Uncontrolled Exposure, 900 MHz frequency band. A conservative MPE limit of 0.6 mW/cm^2 or 6 W/m^2 was used for the calculations of Table 1. For convenience, Table1 provides safe distance for several power levels and antennas besides the worst case for ISM and MAS/MCS bands.

To calculate safe distance:

$$MPED = \sqrt{\frac{(ConductedPower(mW))(DutyCycle)(AntennaGain)}{(4\pi)(ExposureLimt(mW/cm^2)}} \quad \text{eq.2}$$

Where:

MPED is Maximum Permissible Exposure Distance or safe distance.

All quantities are calculated in linear or numeric quantities.

The exposure limit, MPED, and conducted power units must be consistent, mW and cm for this case.

Duty cycle is set using packet sizes for master and slave. The highest duty cycle, 91%, that can be set is 1024 transmit and 64 receive using a modulation of 305 kbps 4FSK. Packet settings are set in the radio Network Configuration Menu. If the radio is a master then master packet size is set to 1024 and slave packet size is set to 64. All radios in the link must have the same master and slave settings. At Power up and with no data transmitting, the radios will transmit or beacon with a duty cycle of 6 to 10% depending upon modulation setting.

The limits for Industry Canada are in Watts per square meter and easily calculated from equations 2 and then 1 above.

Table 1. MPE Safe Distance

MPE Safe Distance vs. Antenna Gain and Power Output Setting						
Power Out Setting (mW)*	**Duty Cycle (linear)**	**Antenna Gain (dBi)**	**Antenna Gain (linear)**	**FCC MPE Limit (mW/cm^2)**	**IC MPE Limit (W/m^2)**	**Safe Distance (cm)**
4000	0.91	6	3.98	0.6	6	33.96
4000	0.91	3	2.00	0.6	6	24.04
1000	0.91	3	2.00	0.6	6	12.02
1000	0.91	6	3.98	0.6	6	16.98
100	0.91	3	2.00	0.6	6	3.80
100	0.91	6	3.98	0.6	6	5.37
10	0.91	3	2.00	0.6	6	1.20
10	0.91	6	3.98	0.6	6	1.70
1	0.91	3	2.00	0.6	6	0.38
1	0.91	6	3.98	0.6	6	0.54

*The worst case is 4000 mW and an antenna with greater than 6 dBi gain or 33.96 cm for MAS/ MCS bands, and 1000 mW and greater than 6 dBi gain or 16.98 cm for ISM.

Introduction

The XETA Radio family is a small form-factor data radio designed for transmitting low to moderate speed data across distances of up to 100 miles. Thus, this radio family has a much longer range than Wi-Fi or other short distance radios, but at a lower data rate capacity.

The radio also has several unique features including the ability to operate on two different bands: a wide bandwidth unlicensed band and a narrow bandwidth licensed band which permits both higher data rates when available, as well as guaranteed delivery of data of lower data rate requirements. The radio can switch between the high data rate mode and the guaranteed delivery licensed mode. In fact, since the radio is software defined, as changing environmental conditions can cause variations in performance, the radio will automatically adjust its operating parameters to maximize performance. Thus, if the signal quality degrades, instead of stopping all transmissions, the radio will reduce data rates, change modulation methods, change frequencies, or enact other modifications to maintain the best data link possible given the conditions.

The design of the radio also includes a physically small size, low weight and very low power consumption while maintaining a robust design over large temperature extremes and other environmental parameters.

Xeta9

The Xeta9 is the 900 MHz version of the XetaWave family. The two radio bands used are the ISM band from 902 to 928 MHz which is unlicensed and allows for a link rate of 4.4 Mbps and the licensed band from 928 to 960 MHz which, depending upon the license obtained can permit operation in a 50 kHz, 25 kHz, 12.5 MHz or other bandwidth channel. Thus the radio is effectively two radios in one: one for high-speed, wide-bandwidth unlicensed operation and one for low-speed narrow-bandwidth licensed operation. The operating mode and parameters are completely controlled by software and can be modified without direct contact with the radio. In addition to the flexible operating bands, the radio also has a high power design of up to 4 Watt transmit power which allows for the 1W FCC ISM band approved operation as well as the higher output power possible in the MAS band.

The XETA9 includes standard modulation methods such as GMSK, 2-level FSK, 4-level FSK, 8-level FSK as well as 2-level, 4-level and 8-level PSK and 16-QAM and 32-QAM. Because the radios have a software defined modulation and detection system, additional modulation methods may be added in the field allowing the radio to benefit from future advances in the industry.

The OEM board has two connectors: one MMCX for the RF signal and one 24-pin header for the user data interface and power. The user data interface connector includes the 4.0-7.5V power for the radio, one standard speed diagnostics/control serial interface of up to 921kbps, one high-speed data serial interface with hardware flow control and several user-definable digital signals.

Xeta9x-S (Emancipator)

The Xeta9x-SB is a cost-reduced and feature-reduced version of the Xeta9m and Xeta9m-SB. The primary difference is that modulations above 2651 kbps 8PSK are not supported.

Installation

The Xeta9 is a board level radio that is intended to be integrated into a customer package. As such the antenna placement must be done in a manner that is in compliance with all local regulations.

This transceiver is only approved for use when professionally installed in devices produced by XetaWave LLC or third party OEMs approved by XetaWave LLC. This transceiver must be installed in a NEMA enclosure.

Antenna Installation for US/FCC

Since professional installation is required, standard RF connectors are used. Adapters or custom coaxial cables may be required to connect the radio output connector to the desired antenna.

Any antenna from a reputable manufacturer with desired bandwidth, gain/pattern coverage, and have an input surge impedance of approximately 50 ohms can be used provided the requirements of Title 47 CFR Part 51.247 (a), (b) and (c) are met, i.e. conducted power of 1W (30 dBm) or EIRP of 4W (36 dBm) maximum and if the antenna gain is greater than 6 dBi, the power setting shall be reduced by the amount the gain of the antenna exceeds 6 dBi. In other words the EIRP cannot exceed 4W or 36 dBm.

XetaWave has successfully tested the Xeta9 with the following antennas:

1. **Device connected**. 3 dBi Omni-Directional Vertical Antenna, LCOM Rubber Duck p/n HG903RD-SM . The power setting for a 3 dBi antenna is 1000 mW.
2. **Directional antenna.** 11 dBi Directional, Yagi vertical antenna, Larson p/n YA5900W The radio power must be reduced by 5 dB to satisfy 47 CFR Part 15.247 (a), (b) and (c) for antenna gain greater than 6 dBi. The power setting for this antenna is 316 mW.

Antenna Installation for Industry Canada

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropic radiated power (E.I.R.P.) is not more than that necessary for successful communication.

This radio transmitter, 11169A-XETA9, has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Heath Canada's website *www.hc-sc.gc.ca/rpb*.

The following antennas are approved for Canadian use as detailed below.

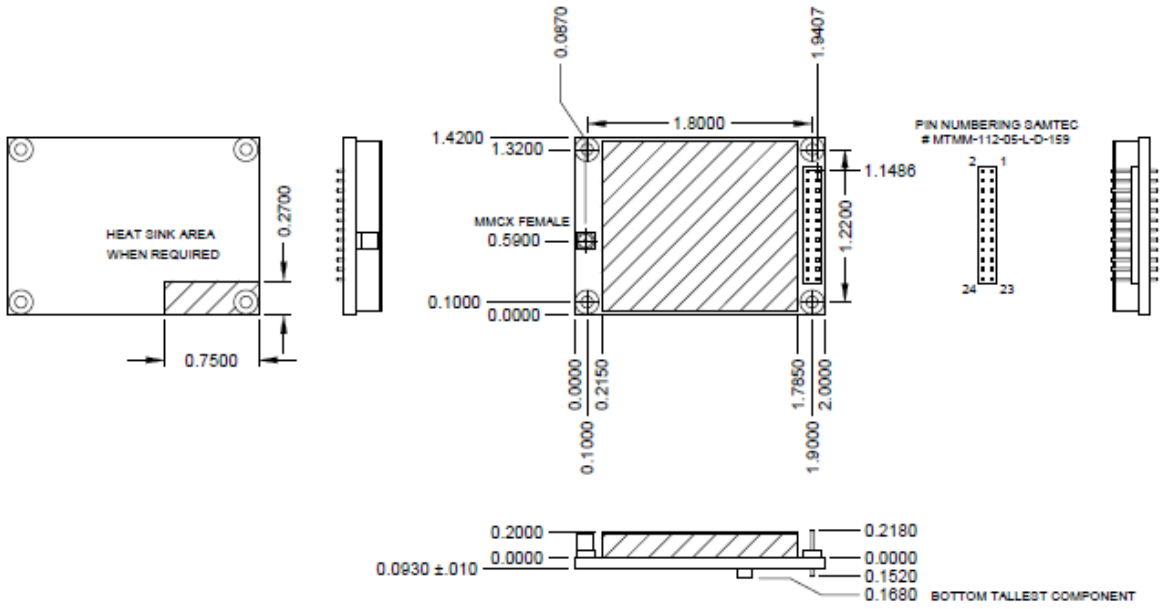
Table 2. Industry Canada Antenna Parameters

IC Antenna Parameters vs. Radio Power Settings							
Type	Gain (dBi)	Antenna	Manufacturer	p/n	Input Impedance (Ω)	Radio Power Setting (mW)	Type
Small, radio connected, omni-directional	3	Rubber Duck (sleeve dipole vertical)	LCOM	HG903RD-SM	50	1000	Small, radio connected, omni-directional
Base station, omni-directional	5.1	Tubular vertical	Commscope / Andrew	DB583-Y	50	1000	Base station, omni-directional
Base station, omni-directional	11.1	Tubular vertical	Commscope / Andrew	DB589-Y	50	309	Base station, omni-directional
Base station directional	11	Yagi	Larsen	YA5900W	50	316	Base station directional
Base station directional	12	Yagi	Wavelink	PRO890-12	50	251	Base station directional
Base station directional	11.1	Yagi	Laird	YB8966	50	309	Base station directional
Base station, omni-directional	8.5	Tubular vertical	Wavelink	PRO902-8	50	562	Base station, omni-directional
Base station, omni-directional	5	Tubular vertical	Wavelink	PRO902-5	50	1000	Base station, omni-directional
Base station, omni-directional	5	Tubular vertical	Laird	FG9023	50	1000	Base station, omni-directional
Base station, omni-directional	8	Tubular vertical	Laird	FG9026	50	631	Base station, omni-directional
Base station directional	11.1	Yagi	Laird	YB8966	50	309	Base station directional

Mechanical Design

Xeta9m

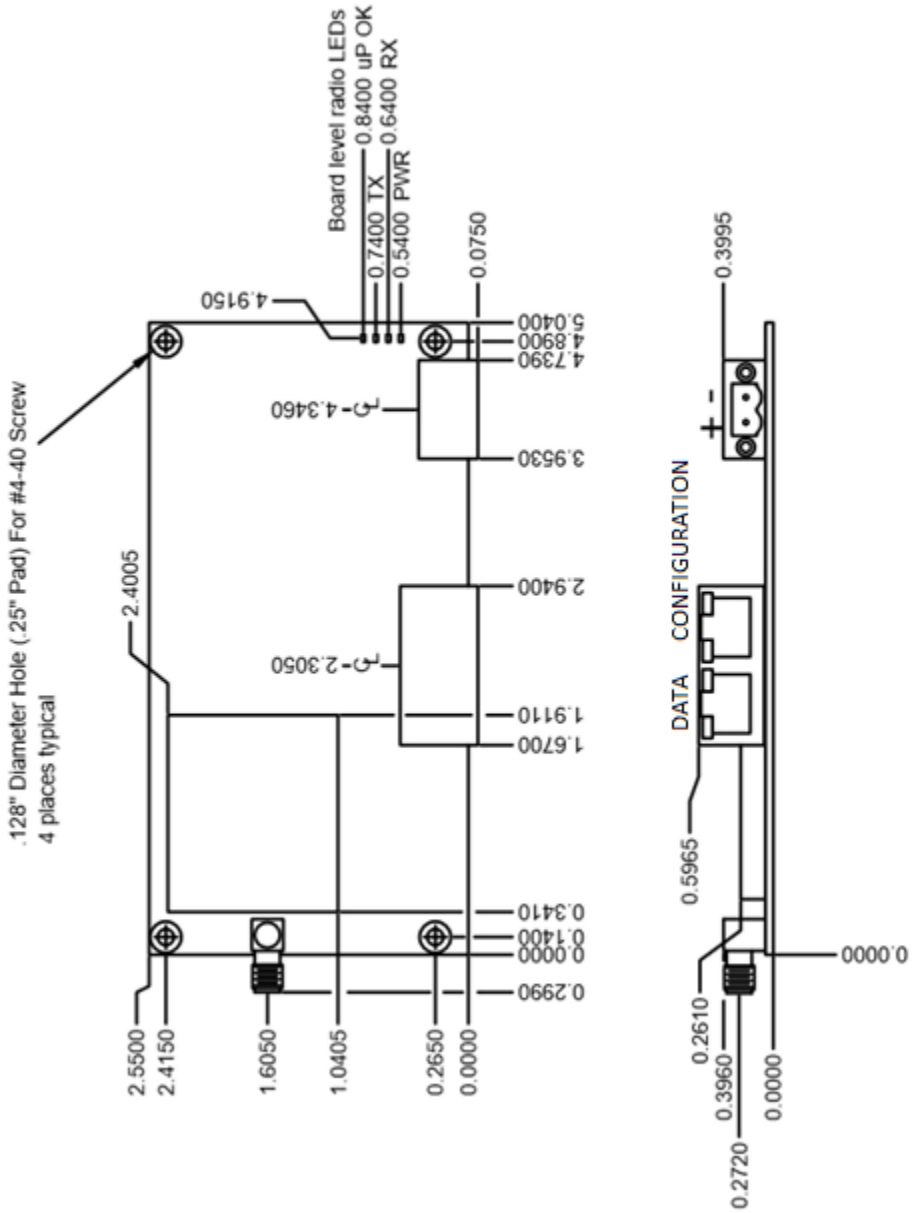
The XETA9 has four mounting holes located 0.100 inches from the outside edge of the board as seen below:



The four mounting holes have a 0.093” diameter finished opening 0.100” from the edges designed for a #2-56 screw. The clearance height of the radio is 0.210” shield height, .103” PCB height, 0.070” back side height. (The connectors are on the side with the shield.)

Heat Sink contact is on the opposite side of the connectors/shield at the lower left corner (back side as shown above).

Xeta9x-S (Emancipator)



Connectors and Electrical Interfaces

Xeta9-m

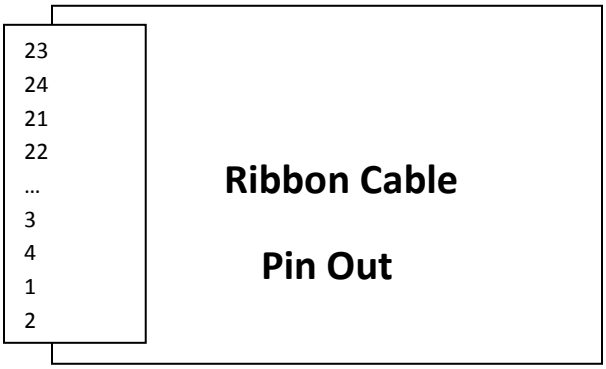
Connector: 24-pin 2-row Samtec part MTMM-112-05-L-D-159

Header assignment:

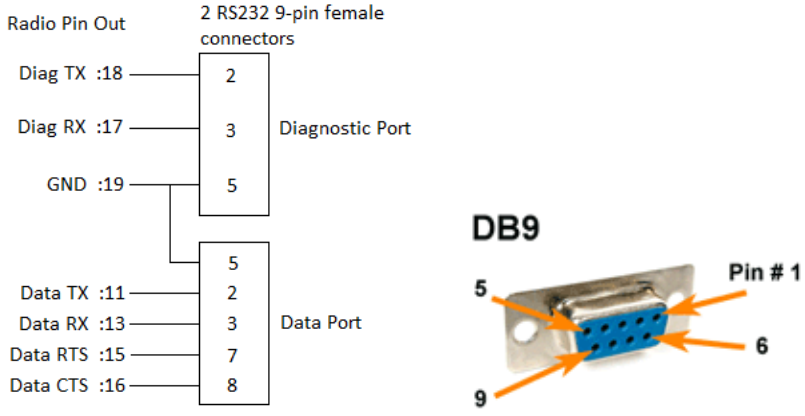
GPIO	:23	24:	GPIO
GPIO	:21	22:	GPIO
Sig GND	:19	20:	Baud Clk
Diag RX	:17	18:	Diag TX
Data RTS	:15	16:	Data CTS
Data RX	:13	14:	Data DCD
Data TX	:11	12:	RSSI (option)
Data DTR	:9	10:	Power GND
Power IN	:7	8:	DNC
DNC	:5	6:	GPIO_HS
DNC	:3	4:	DNC
DNC	:1	2:	DNC

Rows are reversed compared to standard nomenclature.

This means that when a 24 pin connector is used to attach a ribbon cable, the pins will be staggered in a non-conventional way.



The radio pin out may be connected to two DB9 connectors according to the following pin diagram:

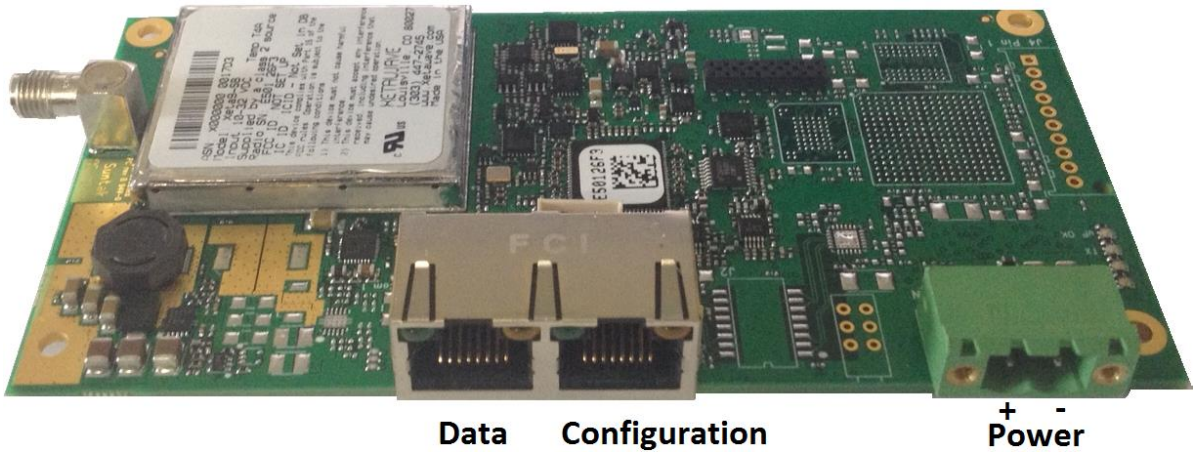


Depending upon configuration, before connecting to a computer, each serial port may need to pass through a 3.3V TTL to RS232 converter such as this SerialComm TTL-232-33P. The radio is either manufactured for a high speed 3.3V interface or for a conventional speed RS-232 interface.

In order to power the radio, 4.5-7.5V DC must be applied across pins 7 and 10. The lower voltage range is acceptable for lower output power operation. If more than 1Watt output power is required or if high order modulation methods are used (3535 kbps 16QAM or higher), then the 7.5V input requirement must be met.

Xeta9-SB

Xeta9x-S (Emancipator)



Configuration

Use a terminal program such as Tera Term, Real Term or Hyperterminal to communication with the Xeta9 configuration port. Serial port settings to communicate with Xeta9 configuration port:

- Baud rate: 115200
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

The computer's serial port must be configured by the user to match this configuration to communicate. Once the radio is connected to the computer, power may be applied to the radio resulting in the following initialization or boot sequence information being displayed on the terminal:

```
spi_init(SPI_BUS_0)
spi_init(SPI_BUS_1)
twi_init()
iox_init()
pll_init(TRUE)
interrupt_init()
timer_init()
mon_init()

XetaWave Bootloader revision 1.17.1410 for rev 5 board

Booting . . .

spi_init(SPI_BUS_0)
spi_init(SPI_BUS_1)
twi_init()
iox_init()
pll_init(TRUE)
interrupt_init()
timer_init()
if_init()
synth_init()
params_load()
sport_init(SPORT_BUS_0)
sport_init(SPORT_BUS_1)
daca_init()
dac_init()
recv_init()
xmit_init()
crc_init()
```

```
math_rand_set_seed(params.serial_number)
ecc_init()
pwm_init()
watchdog_init()
mon_init()
Serial Ports: Data=921600:8N1; Diag=115200:8N1;
Starting . . .
```

Following this, the standard menu based prompt will be displayed. Using this interface, the radio can be controlled and the following parameters can be configured:

Operating Menu

```
                          Operating Menu
         XetaWave MSD9 rev 6, firmware 1.29.1707, SN E5010269
                    Mode: Slave (2) to Master (1)

Frequency     915000000 Hz
Xmit mode     2FSK   57 kbps      Link state        down
Recv mode     2FSK   57 kbps      RSSI                 0  dBm
Fwd power             0 mW        Att level            0
Rev power             0 mW        Xmit rate          0.0  kbps
Supply             4428 mV        Recv rate          0.0  kbps
Amp current           0 mA        Cur success      0.00%
Amp temp             38 C         Avg success     46.10%
Board temp           38 C

0  : Enter configuration menu
1  : Update radio status
2  : Reset all statistics
3  : Enable or disable automatic status updates

Enter selection:
```

If the characters are garbled, or nothing is displayed, then it is likely that the computer's serial port does not match the radio's serial port or the proper converters may not be in use. The radio is shipped from the factory configured at 115200 Baud. This value can be configured differently by the factory upon customer request. Thus, if the radio is new, the computer settings should be verified with a different serial port device. If the radio has had settings changed from the factory settings, then you may need to try different computer baud rates to find the match with the radio.

This screen displays the current configuration of the radio and of importance is the third line with the Mode (Master/Repeater/Slave) of the radio and the mating radio on the other side of the link and the

device addresses (numbered 8 and 1 in the example) of the two radios making the link. In this example, the radio is a Slave unit numbered 8 and will link with a master unit numbered 1.

The 0: option will pause the radio RF operation and display the configuration settings menu as below.
The 1: option will cause the values such as temperature and link state to refresh on screen.
The 2: option will reset the Byte, Error and Packet counters to zero.
The 3: option will turn on or off the automatic refreshing of variables currently displayed.

Operation Reference Map

0: Main Configuration Menu

0: Serial Menu

- 0: Set Data Serial Bit Rate
- 1: Set Data Serial Framing
- 2: Set Data Serial Protocol
- 3: Set Baud Clock Multiplier

1: RF and Hopping Menu

- 0: Toggle between RF Bands
- 1: Set Hop Pattern (ISM Band only)
- 2: Set Hop Frequency Offset (ISM Band only)
- 3: Exclude a Range of Frequencies from Hop Pattern (ISM Band only)
- 4: Set RF Transmit Frequency (Licensed Band only)
- 5: Set RF Transmit Power
- 6: Set Maximum Radio Separation
- 7: Print Hop Frequencies (ISM Band only)

2: Bit Rate and Modulation Menu

- 0::D Toggle between data rates and modulation methods

3: Network Menu

- 0: Set Operating Mode (Master; Slave; Repeater)
- 1: Set Network Type (M to S; M to R to S; M to xS)
- 2: Set Network Address (unique 9-digit value)
- 3: Set Upstream Device Address
- 4: Set Downstream Device Address
- 5: Set Maximum Payload Size, Master
- 6: Set Maximum Payload Size, Slave
- 7: Set Device Address

4: Utilities Menu

- 0: Scan RF Band
- 1: Download Firmware Update
- 2: Scan Network (for information on other radios in the network)

Main Configuration Menu

Upon entering the "0" option the following screen is displayed.

```
                          Main Configuration Menu
              XetaWave MSD9 rev 6, firmware 1.29.1707, SN E5010269
                        Mode: Slave (2) to Master (1)

0  : Serial port configuration menu
1  : RF and hopping menu
2  : Bit rate and modulation type menu
3  : Network menu
4  : Advanced menu
5  : Utilities menu
Esc: Return to previous menu

Enter selection:
```

Serial Port Configuration Menu

If the data serial port needs to be modified, that may be done by option "0".

```
                    Serial Port Configuration Menu

0  : Data serial bit rate            921600 bps
1  : Data serial framing             8N1
2  : Data serial protocol            Raw
3  : Baud clock multiplier           0
4  : Data serial flow control        enabled
     Diagnostic serial bit rate      115200 bps
Esc: Return to previous menu

Enter selection:
```

Each radio has two serial ports for communication; one is a lower speed diagnostics port and the second is a high speed data port. The ports are configured at the time of order for either 3.5V or 5V operation at XetaWave and are not modifiable in the field. The ports are typically configured as 8 bits of data with no parity and 1 stop bit by default. The diagnostics port does not have hardware flow control while the data port does have hardware flow control.

The **diagnostics port** should always be configured to the parameters as listed under the *HyperTerminal* subsection, but the configuration for the **data serial port** is editable through this menu. In order to communicate, the computer's serial port needs to have the same configuration as listed by this menu where, in this example:

Baud rate would be set to 921600. Data bits, parity, and stop bits are given by the three characters in the Data serial framing field. So in this case there are 8 data bits, no parity, and 1 stop bit. The flow control should always be set to hardware.

Option 0: is selected to modify the baud rate, (various speeds in bps will be displayed).
Option 1: is selected to modify the serial framing on the data port.
Option 2: is used only with the Ethernet option and should be left as "Raw" for normal radio operation.
Option 3: is selected to modify the output clock that is synchronous to the data serial port. The output clock may be used to synchronize the user hardware to the radio clock for ease of serial port interface but is not required.

Option 4: is selected to enable or disable hardware flow control for the data port. Flow control should be enabled except in cases where the attached hardware does not provide the flow control signals RTS and CTS.

Note: The diagnostic serial Baud rate is shown for reference but is not adjustable.

Care must be taken when changing the baud rates since the computer must match the expected rate of the radio.

Data Serial Framing

Under the Serial Port Configuration Menu option "1" will lead to the data serial framing menu.

When configuring the data serial framing, the following are examples of valid inputs:

- 7E1
- 8O2
- 5N1.5

The first character, representing data bits can be set from 5 – 8. The second character represents parity and can be set to N, O, or E for none, odd, or even. The last character represents stop bits and can be set to 1, 1.5, or 2.

RF and Hopping Menu

This menu allows for the selection of the frequency characteristics of the radio and can be accessed from the main configuration menu by selecting menu option "1".

Configuration for ISM

Option "0" in the RF menu allows for the selection of the ISM (902-928MHz) band or the MAS (928-960MHz) band. The ISM band is a hopping band resulting in the required setting of the Hop Pattern.

```
                        RF and Hopping Menu

Channels:          171
Bandwidth:         150000 Hz
```

```
Frequency range:  902250000 - 927750000 Hz

0  : RF band                          ISM band
1  : Maximum separation               10 km
2  : MAS transmit power               1000 mW
3  : MAS master transmit frequency    942000000 Hz
4  : MAS slave transmit frequency     942000000 Hz
5  : ISM transmit power               1000 mW
6  : ISM transmit frequency           915000000 Hz
7  : ISM hop pattern                  1
8  : ISM hop offset                   0
9  : ISM start / stop frequency
a  : ISM exclude frequency
b  : Show hop frequencies
Esc: Return to previous menu

Enter selection:
```

Maximum Separation

Option "1" is the distance between the master unit and the farthest slave (or repeater) unit that is connected to the master. This sets the delays for receiving an ACK from a slave and generally slows the network down as the distance increases.

- The maximum distance between master/slave radios is option "1" as stated above. This distance determines the propagation delay so that a short distance will have less delay and a higher throughput. The higher that this parameter is, the lower the data speed but setting this parameter to a smaller value than the actual separation can result in higher error rates.
- **Important:** This parameter must be the same for all radios in a given network

```
                    Maximum Separation

This parameter specifies the maximum distance in km between radios.
Larger values result in lower throughput due to time allocated for
propagation delay.

Current value = 10 km

Enter new value (0 - 200) or Esc to exit:
```

Transmit Power

Option(s) “2” and “5” are the desired RF power output. The power is dynamically adjusted to maintain this value as conditions change. If the load does not permit this power setting, then the power is automatically adjusted to its maximum value. Additionally, thermal monitors continuously measure the output amplifier of the radio and can reduce the power level if the temperature rises above a predefined set limit.

- The RF transmit power sets the power as measured at the connector. This value must be set by the user to be the within the allowed level based on the ISM band or the MAS band with the appropriate antenna attached. The maximum value allowed by the user changes based on which band the radio is configured to operate in.

```
                        ISM Transmit Power

This parameter specifies the desired transmit power in milliwatts for the
ISM band.

Current value = 1000 mW

Enter new value (1 - 1000) or Esc to exit:
```

Hop Pattern

Option “7” in the RF and Hopping Menu will direct you to the ISM Hop Pattern Menu.

```
                        ISM Hop Pattern

This parameter specifies the minimum number of channels spanned by
each hop. The width of a channel is defined by the occupied bandwidth
at the current bit rate and modulation type.  A value of one selects a
pseudorandom hop sequence. A value of zero disables hopping.
This parameter applies only in the ISM band.  Hopping is always
disabled in the MAS band.

Current value = 1

Enter new value (0 - 9) or Esc to exit:
```

In the Hopping Menu you will be able to choose a value between 0, and 9. Those values correspond to the following operations.

Under normal ISM operation (hopping), option “1” is used to set the hopping pattern and option “4” is disabled since there is not a constant frequency.

The ‘hop pattern’ can be set to a number between 0 and 9.

0: Setting the hop pattern to 0 disables hopping.

1: Setting the hop pattern to 1 generates a pseudo random sequence which excludes any frequency adjacent to the previous randomly generated frequency. In this case a seed number is generated by the master radio and communicated to all slave radios and the same sequence of jumps is generated. The sequence is modified so that adjacent channels are not used, thus if the generated sequence is 1, 8, 9, 20, 4… then third sequence value (9) is skipped. The pattern is generated so that each channel is used one time per cycle.

2 – 9: The hop pattern can also be set to any number **n** between 2 and 9, but the number of patterns available is dependent on the number of channels generated for a given bandwidth. In other words a hop pattern of 170 is only available when the radio is operating in a 150 kHz bandwidth which generates 171 channels. The pattern will start at the lowest frequency and skip to every **n**th frequency until the limit for the band is reached (928MHz) at which point the pattern is repeated with an offset equal to one bandwidth value. i.e. for a hop pattern of 3 with a bandwidth of 1 MHz, 26 ((928 MHz – 902 MHz)/ 1 MHz) different frequencies will be generated, centered at each bandwidth, and tested in the following order: **902.5**, 905.5, 908.5, 911.5, 914.5, 917.5, 920.5, 923.5, 926.5, **903.5**, 906.5, 909.5, 912.5, 915.5, 918.5, 921.5, 924.5, 927.5, **904.5**, 907.5, 910.5, 913.5, 916.5, 919.5, 922.5, 925.5, ***902.5...***

Each frequency generated will always be tested exactly once before repeating.

The hopping pattern is a function of the modulation method chosen. The bandwidth of the signal completely fits within the channel bandwidth and the channel bandwidths are 150 kHz, 225 kHz, 300 kHz and 450 kHz for the FHSS modes and 600 kHz, 900 kHz and 1200 kHz for the DTS modes. The maximum number of channels generated is a function of the channel bandwidth and are as follows: 171 channels for 150 kHz, 113 channels for 225 kHz, 84 channels for 300 kHz, and 57 channels for 450 kHz. The DTS channel capacities are: 42 channels for 600 kHz, 28 channels for 900 kHz, 21 channels for 1200 kHz.

Hop Channel Offset

Option “8” will bring you to the Hop Channel Offset menu.

```
                    Hop Channel Offset

This parameter sets the channel at which hopping starts or restarts.
If multi-master synchronization is enabled, hopping restarts at each sync
pulse. Each network must have a different value for this parameter in order
to ensure that the synchronized master radios transmit on different
frequencies from each other at all times.
```

```
This parameter must be set the same for all radios in the same network.

Current value = 0
Enter new value (0 - 65535) or Esc to exit:
```

Option “9” in the RF and Hopping Menu allows a portion of the band at the beginning or end to be excluded from the hopping pattern. This truncates the 26MHz band allowed.

Start/Stop Frequencies

```
                        Start / Stop Frequencies

This selection allows setting a lower and upper limit on frequencies
used. Setting to 0 disables.

Current Value = 902000000 - 928000000 Hz

0  : Band Start  902000000
1  : Band Stop   928000000
Esc: Return to previous menu
```

Option “a” allows for the setting of a band in the hopping range to be excluded. For example if known interference exists between 909MHz and 910MHz, then the Exclude band would start at 909MHz and end at 910MHz.

- The exclude frequency option is used to block out a portion of the band somewhere inside the RF band.

Exclude Frequencies

```
                            Exclude Frequencies

This selection allows blocking a range of frequencies anywhere in the band.

Current value = None

0  : Start  0
1  : End    0
Esc: Return to previous menu
```

Option “b” will display the next set of hop frequencies. If hop pattern “1” is chosen, then the frequency pattern is random and may change depending upon when the display update occurs. Other hop patterns produce a repeatable sequence of frequencies that are used.

The top of the menu lists the current number of channels in the hop table, the bandwidth of the hop table (which will be slightly larger than the bandwidth of the RF signal), and the carrier frequency range of the output.

Configuration for MAS

Since the MAS band is a constant frequency band, hopping is disabled and the transmit frequency is input as option “4”.

```
                              RF and Hopping Menu

Bandwidth:        150000 Hz

0  : RF band                          MAS band
1  : Maximum separation               10 km
2  : MAS transmit power               1000 mW
3  : MAS master transmit frequency    942000000 Hz
4  : MAS slave transmit frequency     942000000 Hz
5  : ISM transmit power               1000 mW
6  : ISM transmit frequency           915000000 Hz
7  : ISM hop pattern                  1
8  : ISM hop offset                   0
9  : ISM start / stop frequency
a  : ISM exclude frequency
b  : Show hop frequencies
Esc: Return to previous menu

Enter selection:
```

Bit Rate and Modulation Type

The various data rates may be chosen from the main menu by selecting option "2" from the main menu. Multiple rates may be selected so that the radio will attempt to operate at the highest data rate possible, but if the signal begins to drop too low, then the data rate will drop so that performance is improved. Alternatively, if only one rate is selected, then only that rate will be used and if the signal quality drops, the link between the radios may drop.

The available bit rate and modulation modes will be different depending on whether the radio is configured to use the ISM or MAS bands.

ISM

```
                          Bit Rate and Modulation Type

This menu selects the bit rate and modulation type mode(s) to use.  Enabling
multiple modes allows the radio to switch modes as needed for best
performance.

0  : *     57 kbps,  2FSK
1  :      114 kbps,  4FSK
2  :      114 kbps,  2FSK
3  :      153 kbps,  2FSK
4  :      229 kbps,  4FSK
5  :      305 kbps,  4FSK
6  :      663 kbps,  2FSK
7  :      884 kbps,  BPSK
8  :     1768 kbps,  QPSK
9  : *   2651 kbps,  8PSK
a  :     3535 kbps, 16QAM
b  :     3535 kbps, 16PSK
Esc: Return to previous menu

Enter selection to enable or disable:
```

The selection of data rate and modulation should be made with knowledge of the expected signal level. Below are typical sensitivity values for different operating modes.

Sensitivity ISM Band (dBm) $\left(10^{-4}\,BER\right)$ (Typical)	-110 @ 115 Kbps -97 @ 1.77 Mbps -108 @153 Kbps -92 @ 2.65 Mbps -100 @ 883 Kbps -88 @ 3.53 Mbps -82 @ 4.4 Mbps

MAS

```
                        Bit Rate and Modulation Type

This selection determines the bit rate(s) and modulation type(s) to use.
Enabling more than one option allows the radio to switch among the enabled
modes depending on operating conditions.

0  :        10 kbps,  2FSK
1  :        20 kbps,  2FSK
2  :        19 kbps,  4FSK
3  :        40 kbps,  4FSK
4  :        29 kbps,  8FSK
5  : *      60 kbps,  8FSK
8  :        36 kbps,  2FSK
9  :        72 kbps,  4FSK
a  :       108 kbps,  8FSK
Esc: Return to previous menu

Enter selection to enable or disable:
```

The selection of data rate and modulation should be made with knowledge of the expected signal level. Below are typical sensitivity values for different operating modes.

Sensitivity MAS Band (dBm) $\left(10^{-4}\ BER\right)$(Typical)	Data Rate (kHz)		
	12.5 kHz	**25 kHz**	**50 kHz**
2 GFSK	12 Kbps, -110	24 Kbps, -107	36 Kbps, -104
4 GFSK	24 Kbps, -103	48 Kbps, -102	96 Kbps, -97
QPSK1	16 Kbps, -111	32 Kbps, -108	48 Kbps, -105
QSPK2	24 Kbps, -107	48 Kbps, -104	96 Kbps, -101
8 PSK	36 Kbps, -101	72 Kbps, -98	144 Kbps, -95
16 QAM	48 Kbps, -97	96 Kbps, -94	192 Kbps, -91
32 QAM	60 Kbps, -91	120 Kbps, -88	240 Kbps, -85

Network Configuration Menu

The Network Configuration defines the radio personality as Master, Slave, or Repeater. There must be one Master on a network. For a point-to-point network, there must be one slave with optional repeaters. On a point-to-multipoint network, there must be at least one slave.

```
                          Network Configuration Menu

0  : Operating mode                 Slave
1  : Network type                   Point-to-point
2  : Network address                12345
3  : Upstream device address        1
4  : Downstream device address      1
5  : Maximum payload size, master   1024 bytes
6  : Maximum payload size, slave    1024 bytes
7  : Our device address             2
8  : Radio name
Esc: Return to previous menu

Enter selection:
```

Option “0” sets the radio as either Master or Slave or Repeater.

Option “1” sets the radio network as either a point-to-point, or point-to-multipoint.

Option “2” is a unique identifier that all radios must share on this network. This unique number allows multiple radio networks to be in the same geographic area but not in communication with each other.

Option “3” is the device address of the upstream radio – either the master if this device is a slave in a point-to-point network, or the unit closer to the master if in a pipeline or repeater configuration. If the unit is the master, then this value is not used.

Option “4” is the device of the downstream radio. Thus, for a point-to-point configuration, the master/repeater will contain the address of the repeater/slave. If the unit is a slave or the network is configured as point to multipoint, then this value is not used.

Options “5” and “6” set the payload size from the master and from the slave. The payload size may be balanced (the same for Master to Slave traffic as for Slave to Master traffic) or unbalanced. If there is more traffic from Master to Slave than from Slave to Master, then to improve throughput performance the Master payload should be set larger than the Slave payload. This value may need to be adjusted in the field based on performance criteria.

```
                    Maximum Payload Size for Master

The Maximum Payload Size for Master/Slave parameters specify the maximum
number of payload bytes per transmitted packet, separately for the Master and
Slave radios.
For example, in an application requiring greater throughput from the master to
the slave, set the master parameter to the maximum value (1024) and the slave
parameter to a lower value (minimum 64).  The time saved transmitting smaller
packets in one direction will increase throughput in the other direction.
For symmetric throughput, set both parameters to the maximum value.
These parameters must be set the same for all radios in the network.

Current value = 1024

Enter new value (64 - 1024) or Esc to exit:
```

Advanced Menu

The "**Beacon Rate**" sets the number transmission slots that the master radio may skip if it has nothing to transmit (or to acknowledge). When set to 0, then every slot that the master can transmit will be used to send the header information and/or payload. When set to 1, then after a successful transmit, if there is no data to send and if there is no remote data to acknowledge, then the master will not transmit for that time slot and will resume transmitting the second time slot. The use of this is to reduce the amount of RF noise in an environment when there is no benefit of the transmission.

```
                    Advanced Settings Menu

0  : Multi-master sync mode          No sync
1  : Idle beacon period              1
Esc: Return to previous menu

Enter selection:
```

Under option "0" in the Advanced Menu one will find the Multi-Master Sync Menu

Multi-Master Sync

On the right side of the dialog are the parameters for the MMS (multi-master sync). This function allows multiple master radios to synchronize their transmit and receive times so that all radios transmit at the same time reducing noise and interference during the receive process. If the radios are set up with the same modulation and packet sizes then the transmit, receive and slot timings are all the same. The synchronization between radios is performed by a one pulse-per-second signal applied to the I/O connector on the side of the radio. The first pin towards the front is the ground and second pin is the

electrical input which requires a 5V square wave 1 Hz waveform. The duty cycle is not critical and should be between 10% and 90%.

The "**MMS**" may operate in one of two modes; "**External**" input (slaved) or internally "**Generate**" (master) the 1Hz signal for other slaves. If an external pulse generator is used (such as from a GPS receiver), than all radios would be set to External. Additionally, the "**MMS Hop Offset**" may be set so that each of the radios operate at a different location in the hop table. For example, if there are 6 frequencies in the hop table, then setting the first radio to "0" and the second radio to "3" results in the radios transmitting at frequencies 0 and 3 for the first slot, frequencies 1 and 4 for the second slot, 2 and 5 for the third slot, 3 and 6 for the fourth slot, 4 and 1 for the fifth slot, and so on. This permits frequency separation between the radios.

Note that the remote radios will be monitoring all of the RF transmits but will only synchronize when the network address and the master device ID match. Thus, each master radio on a MMS system must have a unique network address.

```
                    Multi-Master Sync Mode

This parameter enables synchronized operation between multiple co-
located master radios.  To use synchronization, the master radios must
have their sync pins all wired together.  Additionally, if external
synchronization is selected, a sync pulse source must be connected to
the sync pins of all masters.
This parameter must be set the same for all radios in the same
network. When using synchronization, each master's network should use
a different value for the Hop Offset parameter setting (see RF and
Hopping menu).

Current selection: No sync

0  : No synchronization (normal single master operation)
1  : External synchronization (from GPS or another master)
2  : Generate synchronization pulse (send sync signal to other
masters)
Esc: Return to previous menu

Enter selection:
```

Utilities Menu

A terminal version of the RF scan is provided as a basic utility test tool. This tool receives signal strength as it scans across the ISM band and is designed as a basic trouble shooting tool.

```
freq     dBm
 902.00  -114 ***
 903.12  -114 ***
 904.24  -109 *****
 905.36  -109 *****
 906.48  -106 *******
 907.61  -109 *****
 908.73  -110 *****
 909.85  -115 **
 910.97  -118 *
 912.09  -117 *
 913.21  -112 ****
 914.33  -113 ***
 915.45  -116 **
 916.57  -110 *****
 917.70  -109 *****
 918.82  -110 *****
 919.94  -108 ******
 921.06  -111 ****
 922.18  -111 ****
 923.30  -110 *****
 924.42  -114 ***
 925.54  -114 ***
 926.66  -113 ***
 927.79  -112 ****
Press ESC to exit
```

The Firmware Update tool allows the end user to update the firmware in the radio using the Xmodem file transfer program. Please contact XetaWave for details.

The Scan Network will attempt to contact any other radios on the same network ID and display their information. The master radio will identify all of the slave radios attached.

Configuring Point-to-Point Networks

The point-to-point network consists of a minimum of two radios; a master and a slave, or multiple radios with repeaters inserted between the master and slave. Each radio must be configured for its role in the network. Each radio in the network must have the same network identifier but unique radio identifiers. The master radio has the radio identifier of "1" while the repeaters and slaves have other unique radio identifiers. Each radio has its upstream and/or down-stream radio identifier programmed during configuration.

Typically, the radio is physically installed with an antenna and communications connector before software configuration. The communications connector interfaces with a PC running a terminal services program such as HyperTerminal or TeraTerm. It is critical that the first time the radio and host computer communicate, the serial port connection is configured at 115,200 Baud. If this is not set correctly, then the radio will not communicate with the host. If the menu is displayed on the terminal window, then communication was successful and configuration may proceed.

The minimal steps to configure a radio are:

1) Verify and/or configure the serial port speeds (both diagnostics and data ports)
2) Configure the radio for network operation:
    a. Master, Repeater, or Slave (one master per network)
    b. Network operation of "point-to-point" or "point-to-multipoint"
    c. Network address that is shared by all radios on the network
    d. Radio address of this radio ("1" if master)
    e. Address of radio upstream (closer to the Master)
    f. Address of radio downstream (farther from the Master)
    g. Set the data block size sent downstream and upstream
3) Set the RF data rate speed and modulation method
4) Set either the frequency (if MAS band) or the hopping pattern (if ISM band).
5) Set the transmit power
6) Set the distance between the radios for worst case propagation delay.

Status LEDs

The PWR LED shows radio power and link state. A **red** PWR LED indicates that the radio has power but is not linked. A **green** PWR LED indicates that the radio has power and is linked. Radios configured to Point to Multipoint Master radio always show a **green** PWR LED. All other radio configurations show a **red** PWR LED upon power up until the radio link is established. When the link is established the PWR LED becomes **green**. If the link is dropped, then the PWR LED returns to **red**.

The XMIT/TX LED flashes **red** every time the radio transmits data. Depending on the specific model and age of the radio, this LED may say “XMIT” or “TX”. The functionality remains the same across all different names.

The MODE/RCV/RX LED flashes **green** when the radio is receiving and decoding an RF packet. Depending on the specific model and age of the radio, this LED may show “MODE”, “RCV” or “RX”. The functionality remains the same across all different names.

Because of the high speed of the embedded microprocessor and communications, all status LEDs can turn on and off very quickly. In some cases the LEDs turn on and off so quickly that the LEDs appear to be on but dimly lit. This behaviour indicates that events are happening in very quick succession. A good example is the TX LED changing intensity from dim **red** to bright **red** to off. This indicates many small packets in quick succession (dim **red**), followed by many large packets with almost continuous transmissions (bright **red**), then no transmissions (off).

Status LEDs for Xeta9x-S (Emancipator)

The Xeta9x-S, Emancipator, has in addition to the LEDs listed above a UP OK LED. The UP OK LED indicates that the microprocessor is running.