

Xetawave

XETA4

Spread Spectrum Wireless Data Transceiver

Licensed Spectrum Wireless Data Transceiver

User Manual

Installation Guide

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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.

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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.

Notifications

UL Notification: This product has not undergone UL certification to date.

FCC and IC:

This device complies with parts 15 and 90 of the FCC rules along with IC RSS-210 and SRSP-501. 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.

Caution:

The model number XETA4 has a maximum transmitted output power of 2000mW in the 406.1 to 430 and 450 to 512 MHz bands. It is recommended that the transmit antenna be kept at least 97.3 cm away from nearby persons to satisfy FCC RF requirements.

This 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 and IC RSS-GEN. These limits are designed to provide reasonable protection against harmful energy and interference. If not installed and used in accordance with the instructions, the Xeta4 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 to radio or television reception, 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 receiving antenna.
- 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 radio/TV technician for help.

Note: 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.

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 from 406.1 to 430 and 450 to 512 MHz, 470 MHz maximum for Canada. The radio has a 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, increase power levels, change frequencies, or enact other modifications to maintain the best data link possible given the conditions iaw the licensee's allowed 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 extremes in environmental conditions.

XETA4

The XETA4 is the 400MHz version of the Xeta family.

The XETA4 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. Because the Xeta series 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.

Note

Master terminology indicates the control station or control point for a network.

XETA4 Installation

The XETA4 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.

All transceivers sold under the FCC ID PEJ-### must be installed professionally. This transceiver is only approved for use when 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

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 with the Xeta4. 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, provided the appropriate requirements are met.

US/FCC antenna compliance

FCC Antenna Parameters vs. Radio Power Settings 500W ERP				
Type	Gain (dBi)	Antenna	Input Impedance (Ω)	Radio Power Setting (mW)
Small, radio connected, omni-directional	3	sleeve dipole vertical	50	2000
omni-directional	14.15	Tubular vertical	50	2000
directional	16.15	Yagi	50	2000
Directional, high gain	20.15	Grid Parabolic	50	2000

The RF Exposure section has more power settings vs. antenna gain. The 500W ERP is the maximum allowed by the FCC. Other installations may require different settings depending upon licensing and terrain. The user and/or professional installer is responsible for making the correct calculation for ERP in other environments.

Industry Canada antenna compliance

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-XETA4m, 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 Health Canada’s website www.hc-sc.gc.ca/rpb.

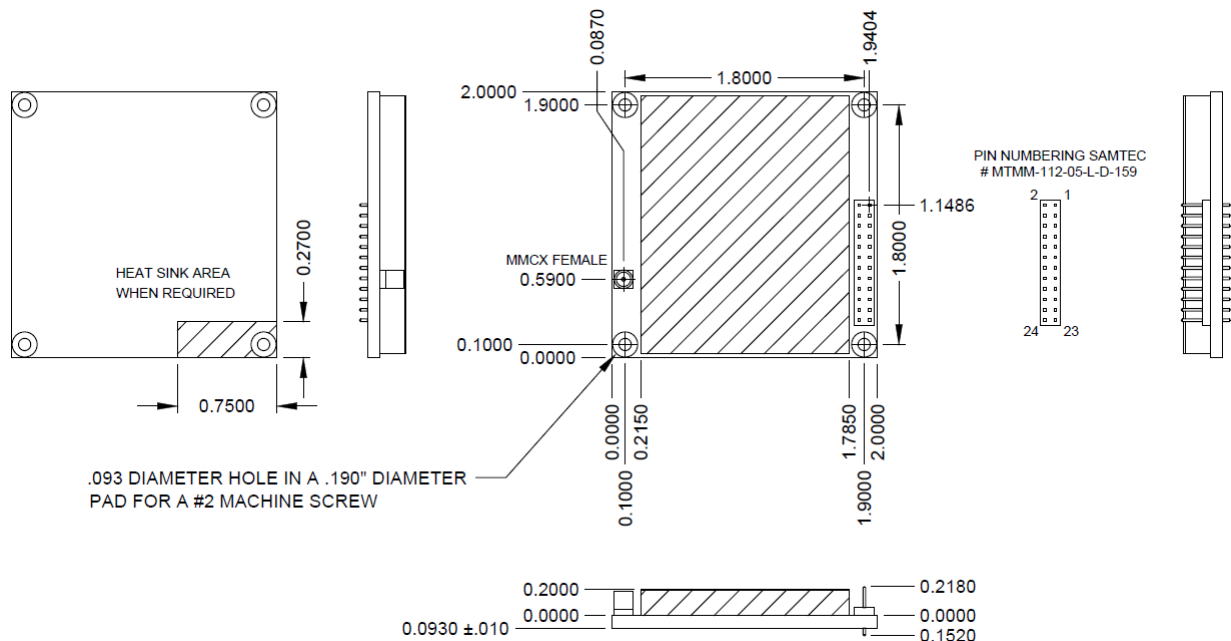
Canada, in SRSP-501, requires a minimum of 9 dBd or 11.15 dBi antenna gain and a maximum of 125W ERP. Table 2 summarizes the power settings for the antenna examples listed.

Table 1. 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)
Base station, omni-directional	11.15	Tubular vertical	ZDA Communications US LLC	ZDAQJ450-9	50	2000
Base station directional	14.15	Yagi	ZDA Communications US LLC	ZDADJ450-12YG	50	2000
Base station directional	16.15	Yagi	ZDA Communications US LLC	ZDADJ450-14YG	50	1889
Base station directional	20.15	Grid Parabola	ZDA Communications US LLC	ZDAGP450C-18-8	50	1186

Mechanical Interface:

The XETA4 has four mounting holes located 0.100 inches from the outside edge of the board as seen below:



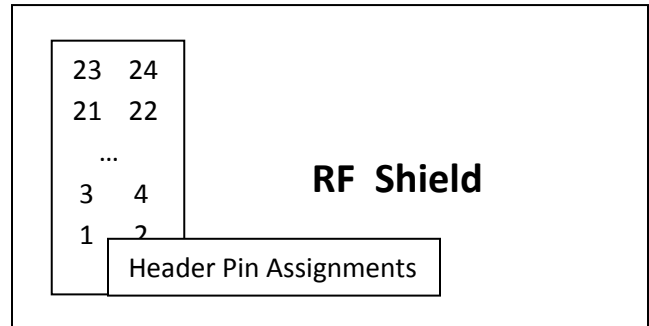
The four mounting holes have a 0.093" diameter finished opening 0.100" from the edges designed for a #2-56 screw. The clearance height of the radio is 0.210" shield height, .103" PCB height, 0.070" back side height. (The connectors are on the side with the shield.)

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

Electrical power/signal interface:

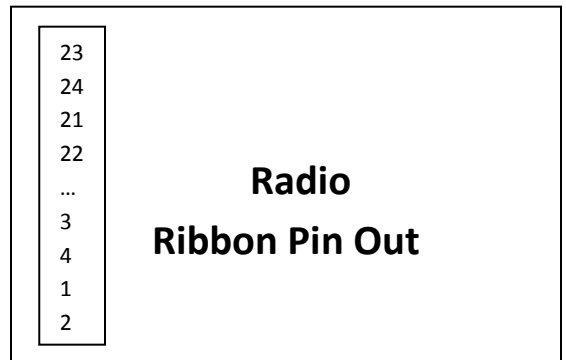
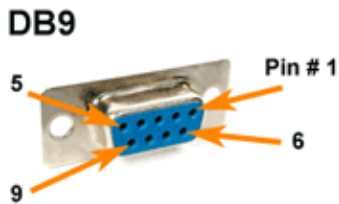
Header assignment: 24-pin 2-row Samtec part MTMM-112-05-L-D-159

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

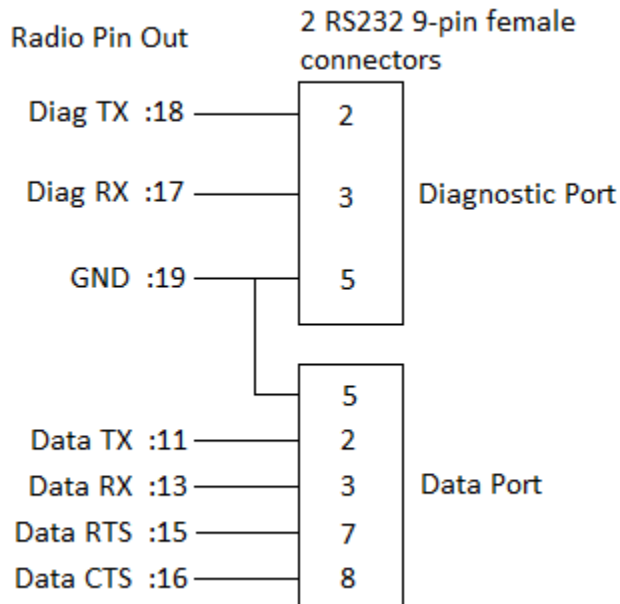


Note: rows are reversed compared to standard nomenclature.

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.

Communicating with the XETA4 using a serial terminal emulator

Bits per Second (Baud):	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 information being displayed on the terminal:

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

Xetawave Bootloader revision x.xx.xxx for rev 4 board

Booting . . .

```
spl_init(SPI_BUS_0)
spl_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()
pwm_init()
watchdog_init()
mon_init()
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:

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 Menu

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

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)

Standard Operating Menu

```
Operating Menu
Xetawave XETA4 rev 5, firmware 1.03.1039
Mode: Slave (8) to Master (1)

Frequency      406000000 Hz
Bit rate       883772 bps      Link state     down
Modulation     2FSK                RSSI           -94 dBm
Fwd power      0 mW              Att level     0
Rev power      0 mW              Xmit rate     569.5 Kbps
Supply         7488 mV          Recv rate     0 Kbps
Amp current    0 mA              Cur success   100.00%
Amp temp       32 C              Avg success   100.00%
Board temp     32 C

0 : Pause operation and enter configuration menu
1 : Update radio status
2 : Reset error/packet/byte counters
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.

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

```

                                Main Configuration Menu
                                Xetawave XETA4 rev 5, firmware 1.03.1039
                                Device address: 1 Mode: Slave

0 : Serial Port Configuration Menu
1 : RF and Hopping Menu
2 : Bit Rate and Modulation Type Menu
3 : Network Menu
4 : Utilities Menu
Esc: Resume Radio Operation

Enter selection:
```

Serial Port Configuration

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           115200 bps
1 : Data serial framing            8N1
2 : Data serial protocol          Raw
3 : Baud clock multiplier         0
   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 115200. 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.

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.

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

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.

The baud rate for the data port can be changed by selecting "0" and the various speeds will be displayed:

```
                                Data Serial Bit Rate

This parameter specifies the serial bit rate in bits/second for
the data port.

Current selection: 115200 bps

0   :   1200 bps                b   : 1049479 bps
1   :   2400 bps                c   : 1259375 bps
2   :   4800 bps                d   : 1574219 bps
3   :   9600 bps                e   : 2098958 bps
4   :  19200 bps                f   : 3148438 bps
5   :  38400 bps                g   : Enter a bit rate
6   :  57600 bps
7   : 115200 bps
8   : 230400 bps
9   : 460800 bps
a   : 921600 bps
Esc: Return to previous menu

Enter selection:
```

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

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

7E1
8O2
5N1.5
8N1

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 Configuration

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".

Menu for 400 MHz band operation:

```
RF Configuration Menu

Channels:    21
Bandwidth:   12500
Freq Range:  406000000 - 512000000
Exclude:    1 - 1

0 : RF band           Licensed band
1 : Hop pattern       N/A
2 : Hop frequency offset N/A
3 : Exclude frequencies N/A
5 : RF transmit power 2000 mW
6 : Maximum separation 0 km
7 : Print Hop Frequencies N/A
Esc: Return to previous menu

Enter selection:
```

Option "5" is 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.

Option "6" 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 RF transmit power sets the power as measured at the connector. This value must be set by the user to be within the allowed level based on regulatory limits with the appropriate antenna attached.

```
Transmit Power

This parameter specifies the desired transmit power in milliwatts.

Current value = 500 mW

Enter new value (0 - 2000) or Esc to exit:
```

The final RF input is the maximum distance between master/slave radios. 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 = 2 km

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

Bit Rate and Modulation Configuration

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.

Operating modes:

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	: 8 kbps, 2GFSK
1	: 16 kbps, 4GFSK
2	: 12 kbps, QPSK1
3	: 18 kbps, QPSK2
4	: 27 kbps, 8 PSK
5	: 36 kbps, 16 QAM
6	: 45 kbps, 32 QAM
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 (10^{-4} BER) Uncorrected (No ECC)	-111dB @ 8.0 kbps (12.5kHz BW) 2-level GFSK -104dB @ 16.0 kbps (12.5kHz BW) 4-level GFSK -112dB @ 12.0 kbps (12.5kHz BW) QPSK 1 -118dB @ 18.0 kbps QPSK2 -102dB @ 27 kbps 8 PSK -98dB @ 36 kbps 16 QAM -92dB @ 45 kbps 32 QAM
--	---

Network Configuration

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           Master
1 : Network type            Point-to-point
2 : Network address         012345678
3 : Upstream device address 0
4 : Downstream device address 256
5 : Maximum payload size, master 1024 bytes
6 : Maximum payload size, slave 1024 bytes
7 : Our device address      1
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 16). 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 = 255

Enter new value (16 - 1024) or Esc to exit:

Utilities

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.

Point-to-Point Network

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 emulation 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 the transmit power
 - 5) Set the distance between the radios for worst case propagation delay.

LED Display

The radio board has 4 LEDs mounted near the edge that indicate: power applied, transmit in progress, receive in progress, and a spare for special use.

If the radio is mounted inside the Ethernet enclosure, then the radio LEDs are routed to the enclosure with the following details. On the right side of the radio enclosure are six LED's. The three on the left display the status of the first radio and the three on the right display the status of the second. From top to bottom, each LED indicates the following:

The first LED (top) turns red when the radio is powered on and will subsequently turn green once the radio has established a link.

The second LED flashes red when the radio is transmitting data.