Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!


## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

# 9XTend-PKG-E™ Ethernet RF Modem




**Product Manual v2.x4x**

For RF Modem Part Numbers: XT09-PK...-E...

**1 Watt Transmit Power, 256-bit AES Encryption**


MaxStream®

355 South 520 West, Suite 180

Lindon, UT 84042

Phone: (801) 765-9885

Fax: (801) 765-9895

rf-xperts@maxstream.net

www.MaxStream.net (live chat support)



M100217

2007.01.04

**Technical Support:** Phone: (801) 765-9885

Live Chat: www.maxstream.net

E-mail: rf-xperts@maxstream.net

# Contents



# 1. 9XTend Ethernet RF Modem

The 9XTend RF Modem affords OEMs and integrators an easy-to-use RF solution that sustains reliable delivery of data between remote devices.

Out-of-box, the modem is configured to immediately sustain long range wireless links between devices. Simply feed serial data into one modem then the data will surface on the other end of the wireless link. The modem transfers a standard asynchronous serial data stream between devices.

## 1.1. Key Features

**Long Range Data Integrity**

**1 Watt Power Output** (variable 1mW - 1W)

Range (@9,600 bps throughput data rate):

- Indoor/Urban: **up to 3000'** (900 m)
- Outdoor RF line-of-sight: **up to 14 miles** (22 km) w/dipole antenna
- Outdoor RF line-of-sight: **up to 40 miles** (64 km) w/high-gain antenna

Range (@115,200 bps throughput data rate):

- Indoor/Urban: **up to 1500'** (450 m)
- Outdoor RF line-of-sight: **up to 7 miles** (11 km) w/dipole antenna
- Outdoor RF line-of-sight: **up to 20 miles** (32 km) w/high-gain antenna

Continuous RF data stream up to **115,200 bps**

Receiver Sensitivity: **-110 dBm** (@ 9600 baud), **–100 dBm** (@ 115200 baud)

**Advanced Networking & Security**

True Peer-to-Peer (no Master device required), Point-to-Point, Point-to-Multipoint & Multidrop

Retries and Acknowledgements

FHSS (Frequency Hopping Spread Spectrum)

10 hopping channels, each with over 65,000 unique network addresses available

**256-bit AES Encryption**
(AES algorithm is FIPS-197 certified)

**Low Power**

7 - 28 V Supply Voltage

Serial Port and Cyclic software sleep modes supported

**Easy-to-Use**

No configuration necessary for out-of box RF communications

Free X-CTU Software
(Testing and configuration software)

RF Modems easily configured using standard AT & binary commands

Transparent Operation
(Wireless links replace serial wires)

API Operation
(Frame-based communications)

Portable
(small form-factor easily designed into a wide range of data systems)

Software-selectable I/O interfacing rates

Multiple data formats supported
(parity, start and stop bits, etc.)

XII™ Interference Immunity

No Master/Slave setup dependencies

**Free & Unlimited Technical Support**

### 1.1.1. Worldwide Acceptance

**FCC Approved** (USA) Refer to Appendix A [p56] for FCC Requirements.
Systems that include XTend RF Modems inherit MaxStream's Certifications.

**ISM** (Industrial, Scientific & Medical) license-free 902-928 MHz frequency band

Manufactured under **ISO 9001:2000** registered standards

**ESD (Electrostatic Discharge) immunity** - ESD-hardened and IEC1000-4-2 (Level 4) tested

9XTend RF Modems are optimized for use in the **US**, **Canada**, **Australia and Israel**

## 1.2. Specifications

The XTend-PKG-E RF Modem ships configured to provide immediate long range wireless links between devices. The modem can be configured for additional functionality using standard AT and binary commands [Refer to the Command Mode [p18] & RF Modem Configuration [p20] sections].

The built-in Ethernet interface makes RF data available to any TCP/IP network. Once connected to a network, the XTend-PKG-E can be accessed through telnet; or, when used with the included Com Port Redirector Software, it can be mapped to a com port and accessed as a serial device.

**Table 1-01. 9XTend-PKG-E Ethernet RF Modem Specifications**

| **9XTend 900 MHz Ethernet RF Modem Specifications** | | | |
|---|---|---|---|
| **Performance** | | @9600 bps Throughput Data Rate | @115200 bps Throughput Data Rate |
| Transmit Power Output (software selectable using PL command) | | 1mW - 1 Watt | 1mW - 1 Watt |
| Indoor/Urban Range | | Up to 3000' (900 m) | Up to 1500' (450 m) |
| Outdoor RF line-of-sight Range | | Up to 14 miles (22 km) w/ dipole antenna<br>Up to 40 miles (64 km) w/ high-gain antenna | Up to 7 miles (11 km) w/ dipole antenna<br>Up to 20 miles (32 km) w/ high-gain antenna |
| Interface Data Rate (software selectable using BD command) | | 1200 – 230400 bps | 1200 – 230400 bps |
| RF Data Rate | | 10,000 bps | 125,000 bps |
| Receiver Sensitivity | | -110 dBm | -100 dBm |
| **Power Requirements** | | | |
| Supply Voltage | | 7 - 28V | 7 - 28V |
| Receive Current | | 270 mA | 270 mA |
| Serial Port Sleep Power Down | | 210 mA | 210 mA |
| Idle Currents (9V supply voltage) | 16 sec cyclic sleep (SM=8) | 211 mA | 210 mA |
| | 8 sec cyclic sleep (SM=7) | 212 mA | 210 mA |
| | 4 sec cyclic sleep (SM=6) | 214 mA | 211 mA |
| | 2 sec cyclic sleep (SM=5) | 218 mA | 212 mA |
| | 1 sec cyclic sleep (SM=4) | 224 mA | 215 mA |
| **Networking & Security** | | | |
| Frequency | | 902-928 MHz | |
| Spread Spectrum | | FHSS (Frequency Hopping Spread Spectrum) | |
| Modulation | | FSK (Frequency Shift Keying) | |
| Network Topologies Supported | | Peer-to-Peer ("Master/Slave" relationship not required), Point-to-Point, Point-to-Multipoint & Multidrop | |
| Channel Capacity | | 10 hop sequences share 50 frequencies | |
| Supported Network Protocols | | ARP, UDP, TCP, ICMP, Telnet, TFTP, AutoIP, DHCP, HTTP and SNMP | |
| Encryption | | 256-bit AES Encryption – Refer to the KY Command to implement | |
| **Physical Properties** | | | |
| RF Modem Board Size | | 2.750" x 5.500" x 1.125" (6.99cm x 13.97" x 2.86cm) | |
| Weight | | 7.1 oz. (200g) | |
| Serial Connector | | RJ-45 Female Ethernet Connection | |
| Operating Temperature | | -40 to 85º C (industrial) | |
| **Antenna** | | | |
| Connector | | RPSMA (Reverse-polarity SMA) | |
| Type | | Half-wave dipole whip, 6.75" (17.15cm), 2.1 dBi gain | |
| Impedance | | 50 ohms unbalanced | |
| **Certifications** (partial list) | | | |
| FCC Part 15.247 | | OUR-9XTEND | |
| Industry Canada (IC) | | 4214A-9XTEND | |

**Table 1-02. 9XTend-PKG-E Ethernet RF Modem Specifications - Relative to user-selected TX Power Output**

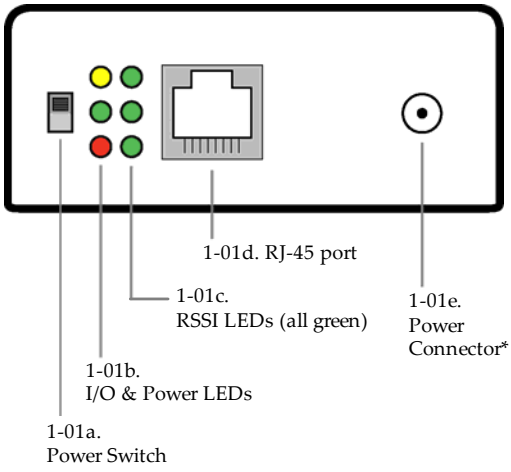
| **Power Requirements (TX currents relative to each TX Power Output option)** | | | | | |
|---|---|---|---|---|---|
| **Transmit Power Output** | **1 mW** | **10 mW** | **100 mW** | **500 mW** | **1 W** |
| Typical Transmit Current* (@115.2 Kbps) 9 VDC supply voltage | 270 mA | 290 mA | 380 mA | 600 mA | 830 mA |

* Divide by 2 for 18V supply (constant wattage from 7-28V)

## 1.3. External Interface

**Figure 1-01. Front View**




### 1-01a. Power Switch

Move Power Switch to the ON (up) position to power the XTend Ethernet RF Modem.

### 1-01b. I/O & Power LEDs

LEDs indicate modem activity as follows:

Yellow (top LED) = Serial Data Out (to host)
Green (middle) = Serial Data In (from host)
Red (bottom) = Power/TX Indicator (Red light is on when powered; it pulses on/off briefly during RF transmission.)


### 1-01c. RSSI LEDs

RSSI LEDs indicate the amount of fade margin present in an active wireless link. Fade margin is defined as the difference between the incoming signal strength and the modem's receiver sensitivity.

3 LEDs ON = Very Strong Signal (> 30 dB fade margin)
2 LEDs ON = Strong Signal (> 20 dB fade margin)
1 LED ON = Moderate Signal (> 10 dB fade margin)
0 LED ON = Weak Signal (< 10 dB fade margin)

### 1-01d. RJ-45 Ethernet Port

Standard Female RJ-45 connector is used to connect unshielded twisted-pair CAT5 cabling.

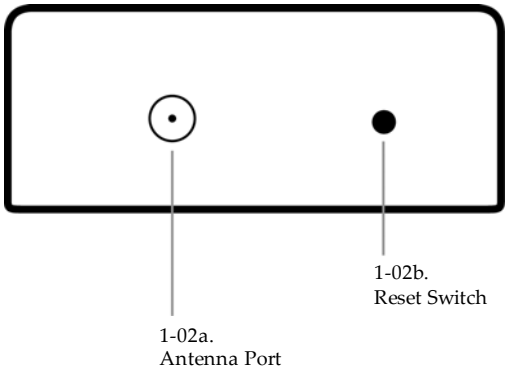
### 1-01e. Power Connector*

7-28 VDC power connector

* The Ethernet RF Modem does not support Power-over-Ethernet (PoE). The device cannot be powered directly from a PoE port on a compatible hub.

However, it may be useful to send power on the unused wires of the CAT-5 cable in a situation where the radio will be mounted in a location that optimizes radio coverage, but may not have a power outlet nearby. There are several third party devices available that can inject the power onto the cable and then remove it at the remote side.

**Figure 1-02. Back View**




### 1-02a. Antenna Port

The antenna port is a 50Ω RF signal connector for connecting to an external antenna. The connector type is RPSMA (Reverse Polarity SMA) female. The connector has threads on the outside of a barrel and a male center conductor.

### 1-02b. Reset Switch

The Reset Switch is used to reset (re-boot) the RF modem and force the modem into AT Command Mode.

To reset (re-boot) the modem: Press and then immediately release the Reset Switch.

To force the modem into AT Command Mode (at the default throughput data rate of the modem): Press the Reset Switch and keep it depressed for at least two seconds, then release.

# 2. System Setup

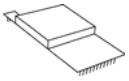
## 2.1. Data Radio System Components

MaxStream RF Modems were designed to provide reliable wireless links between devices contained in a data system. The PKG-E Ethernet RF Modem allows integrators to connect the MaxStream Modems into an Ethernet network.

The following devices will be used to describe a data system that includes the XTend-PKG-E Ethernet RF Modem:

**XTend-PKG-E Ethernet RF Modem ("PKG-E")**: The Ethernet RF Modem is an Ethernet-connected serial modem used for communication with other MaxStream serial modems. The Ethernet RF Modem is not a wireless Ethernet Bridge intended for Ethernet connectivity on both the remote and base ends of a wireless link.

**XTend-PKG-R RS-232/485 RF Modem ("PKG-R")**: The RS-232/485 RF Modem is a serial modem that can be identified by its DB-9 serial port and 6-switch DIP Switch.

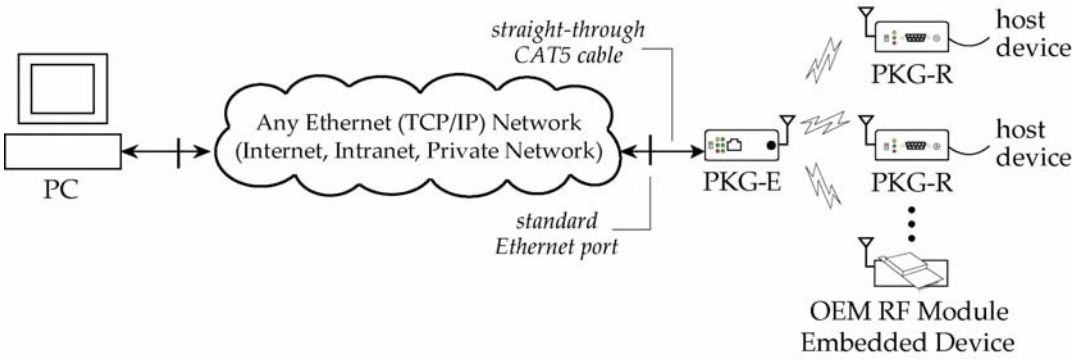


**XTend OEM RF Module ("OEM RF Module")**: The OEM RF Module is mounted inside all XTend-PKG RF Modems and may be integrated into OEM-designed products to transmit and receive data over-the-air.

### 2.1.1. System Description

The PKG-E Ethernet RF Modem can be used as an access point in a network of MaxStream RS-232/RS-485 RF Modems (or other OEM RF Module Embedded Devices). XTend RF Modems support point-to-point, peer-to-peer, point-to-multipoint and multidrop network topologies. Below is an example of a typical point-to-multipoint application:

**Figure 2-01. XTend-PKG-E Ethernet RF Modem in a Point-to-Multipoint Data Radio System**




The Ethernet-connected RF modem supports com port and Telnet connection options:

- "Com Port Redirector Software enables legacy serial applications to communicate with the Ethernet RF Modem by forwarding serial data over Ethernet.
- "Telnet communicates directly to the Ethernet RF Modem using port 14001. Refer to the "Test Communications (Telnet Loopback)" section [p12] for an example that by-passes the com port.

## 2.2. Com Port Communications

### 2.2.1. Install Software

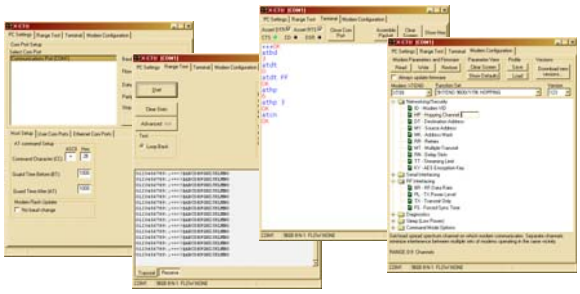
The X-CTU and Com Port Redirector software facilitate communications through a PC com port. Follow the instructions below to setup a com port for configuring and testing the RF modem.

**Installation #1: X-CTU Software (version 4.8.0 or higher*)**

Use the X-CTU software to configure the Ethernet RF Modem and PC com port. The software is divided into four tabs:

- PC Settings tab - Setup PC serial com ports to interface with RF modem
- Range Test tab - Test RF modem's range under varying environments
- Terminal tab - Test serial communications and set/read RF modem parameters
- Modem Configuration tab - Set/read RF modem parameters

**Figure 2-02. Tabs of the X-CTU Software**



* To verify X-CTU version number, click on the icon located in the top-left corner of the X-CTU user interface and then select the "About X-CTU…" menu item.

**To Install the X-CTU Software:**

Double-click the "setup_X-CTU.exe" file then follow prompts of the installation screens. This file is located on the MaxStream CD and under the 'Downloads' section of the following web page: www.maxstream.net/helpdesk/download.php.

**Installation #2: Ethernet Com Port Redirector**

MaxStream provides com port redirection software that creates a com port in the operating system that will forward serial data to the IP address of the Ethernet-connected RF modem. The Ethernet RF Modem can then be accessed as though it were a serial device.

The Ethernet Com Port Redirector must be installed separately to enable the "Ethernet Com Ports" sub-tab of the X-CTU "PC Settings" tab. If this software is not installed, the features under the "Ethernet Com Ports" section are grayed and cannot be used.

The "Ethernet Com Ports" sub-tab enables user to perform functions such as the following:

- Discover Ethernet RF Modems on a network
- Setup serial com ports for XTend-PKG-E Ethernet RF Modems
- Identify, assign and modify Ethernet RF Modem IP addresses

**To Install the Ethernet Com Port Redirector:**

1. Double-click the "setup_ComPortRedirector.exe" file then follow prompts of the installation screens. This file is located in the "software" folder of the MaxStream CD.
2. Re-boot the PC to complete installation.

## 2.2.2. Setup Com Port and IP Address

The XTend-PKG-E Ethernet RF Modem supports DHCP (Dynamic Host Configuration Protocol) and Auto IP protocols. Both protocols automatically assign IP addresses to nodes of a network.

### Ethernet RF Modem Discovery

The X-CTU Software provides an easy-to-use interface that searches a local network and then displays Ethernet RF Modems found.

**Discover Ethernet RF Modem, Map Com Port & Assign IP Address:**

1. Install both the X-CTU and the Ethernet Com Port Redirector software [See "Install Software" section on previous page]. Re-boot the PC if prompted to do so.
2. Launch the X-CTU Software and select the PC Settings tab; then select the "Ethernet Com Ports" sub-tab. [Figure 2-03]
   --> After the Com Port Redirector is installed (& PC is re-booted), a "Setup Com Port" dialog box will appear the first time the "Ethernet Com Ports sub-tab is selected. For subsequent uses of the sub-tab, select the 'New IP Address' button and proceed to step 4.
3. Select the 'OK' button.
   --> All discovered PKG-E Ethernet RF Modems will be displayed in a new "Assign IP Address" dialog box. [Figure 2-04]
4. Highlight one of the discovered Ethernet RF Modems (Modem IP and Hardware Addresses are listed in the "...discovered Ethernet Modem" section) [Figure 2-04]. If an Ethernet Modem is not discovered, enter the IP address manually in the "Enter IP Address..." box.
5. Select the 'OK' button.
   --> Newly assigned Ethernet Modem is listed under the "Ethernet Com Ports" sub-tab and the first available com port is assigned to it. Note that its status is "Queued as new".
6. Select the 'Apply' button [located in the 'Changes' section of the "Ethernet Com Ports" sub-tab - Figure 2-03]. Even if an Ethernet RF Modem appears in the 'Ethernet Com Port' list, the new com port cannot be used until changes are applied and the PC is re-booted.
7. Re-boot the PC; then re-launch the X-CTU Software. The com port can now be used to communicate with the RF modem.

**Figure 2-03. Ethernet Com Ports sub-tab**
(Ethernet Com Ports sub-tab is enabled by installing the Ethernet Com Port Redirector Software.)

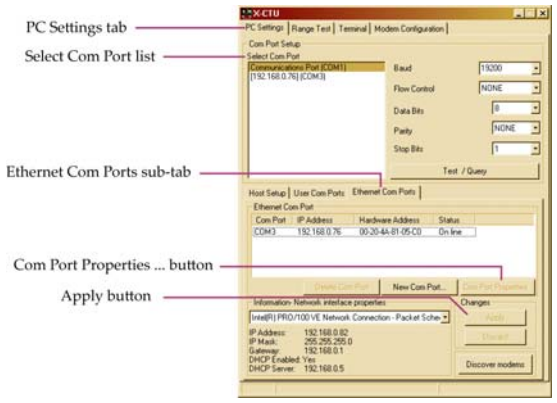



**Figure 2-04. Assign IP Address dialog box**

NOTE: If the Ethernet RF Modem is left in DHCP mode, it may become necessary to reconfigure a mapped com port any time an IP address is re-assigned by the DHCP server. Dynamic addressing is supported, but assigning a static IP address can simplify the application.

### 2.2.3. Assign Static IP Address

To assign a static IP address to the Ethernet RF Modem, follow the steps outlined below. A static IP address may be necessary when:

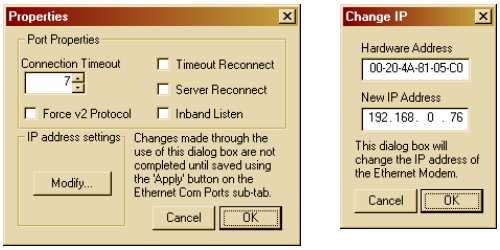
- The Ethernet RF Modem and the host PC are on different subnets
- The Ethernet RF Modem IP address might be changed by a DHCP server

**Configure a static IP address on a local network:**

1. Install both the X-CTU Software and the Ethernet Com Port Redirector software [See "Com Port Communications" section - p8]. Re-boot the PC if it has not been re-booted since the installation of the Ethernet Com Port Redirector.
2. Launch the X-CTU Software and select the "PC Settings" tab; then select the "Ethernet Com Ports" sub-tab [Figure 2-03]
   --> After the Ethernet Com Port Redirector is installed (and PC is re-booted), a "Setup Com Port" dialog box will appear the first time the "Ethernet Com Ports" sub-tab is selected. The following steps are written under the assumption the sub-tab has already been selected at least one time.
3. Select the "Discover modems" button to display which modems are on-line and which are not; then click the 'OK' button of the "Discover Ethernet Modems" dialog box.
4. Click-on and highlight an Ethernet RF Modem from the 'Ethernet Com Ports' list.
5. Select the 'Com Port Properties' button [Figure 2-03].
6. Select the 'Modify' button of the "Properties" dialog box [Figure 2-05].
7. Type a new IP address; then select the 'OK' button [Figure 2-05].
8. Select the 'OK' button of the "Properties" dialog box.
9. Select the 'Apply' button that is under the 'Changes' section of the "Ethernet Com Ports" sub-tab.

--> XTend-PKG-E Ethernet RF Modem re-boots and the new IP Address is saved.

**Figure 2-05. Properties & Change IP dialog boxes**




### 2.2.4. Change Com Port Number

During Com Port Redirector setup, one com port is automatically assigned. Additional com ports are user-assigned. Use the following steps to manually change a com port number:

**Change Ethernet RF Modem's Com Port Number:**

1. Once the Ethernet RF Modem is recognized and displayed under the "Ethernet Com Ports" sub-tab, select the 'New Com Port' button. Follow the steps outlined in the "Ethernet RF Modem Discovery" section [p9].
2. Type-in the IP Address of the Ethernet Modem and highlight a com port number; then select the 'OK' button.
3. Select the 'Apply' button; then re-boot the PC if prompted to do so.
4. Go to the 'Ethernet Com Ports' sub-tab of the X-CTU Software's 'PC Settings' tab.
5. Highlight the old com port entry, select the 'Delete Com Port' button, then select the 'Apply' button.

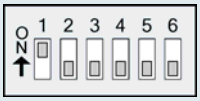
## 2.2.5. Test Communications (X-CTU Loopback)

When testing a wireless link, consider using the following components:

- XTend-PKG-E Ethernet RF Modem (connected to a local network)
- XTend-PKG-R RS-232/485 RF Modem (w/ loopback adapter)
- PC (connected to a local network)
- Accessories (Loopback adapter, CAT5 UTP cable, power supplies and RPSMA antennas)

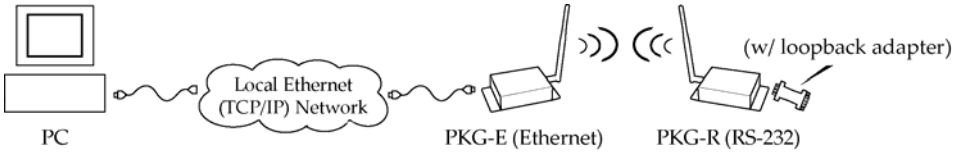
**Hardware Setup for Loopback Test:**

1. Connect the XTend-PKG-E (Ethernet) RF Modem and a PC to active Ethernet ports of the same local network using CAT5 cables (included w/ PKG-EA accessories package).
2. Attach the serial loopback adapter to the DB-9 serial connector of the XTend-PKG-R (RS-232) RF Modem. The serial loopback adapter configures the PKG-R RF Modem to function as a repeater by looping serial data back into the modem for retransmission.
3. Configure the PKG-R (RS-232) RF Modem for RS-232 operation using the built-in DIP Switch. Dip Switch 1 should be ON (up) and the remaining switches should be OFF (down).




4. Attach RPSMA antennas to both RF Modems.
5. Power both RF Modems with power supplies (included w/ accessories package).

**Figure 2-06. Hardware Setup for Testing a Wireless Link**



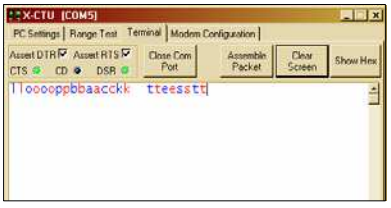

**Test Wireless Link (X-CTU Method):**

1. Follow the steps in the "Ethernet RF Modem Discovery" section [p9].
2. Setup hardware as shown in the "Hardware Setup..." steps above [Figure 2-06].
3. Select the 'PC Settings' tab of the X-CTU Software; then highlight the Com Port that is forwarded to the PKG-E (Ethernet) RF Modem.
   --> Make sure PC com port settings (Baud rate, Parity, etc.) on the "PC Settings" tab match those of the Ethernet RF Modem.
4. Select the 'Terminal' tab of the X-CTU Software.
5. Begin typing characters into the terminal window.

   --> Characters typed in the terminal should be echoed back to the screen [Figure 2-07]. Sent characters appear in blue and received characters in red. With each character typed, the 'Data Out' and 'Data In' LEDs should flash briefly on each of the RF Modems.

   --> To double-check the wireless link, turn off the power going to the remote PKG-R (RS-232) RF Modem and leave the PKG-E Modem turned on. Type characters into the Terminal Window of the X-CTU Software and note that characters are not echoed back.

**Figure 2-07. Terminal Tab of MaxStream's X-CTU Software**



## 2.3. Telnet Communications

In addition to com port communications, Telnet communications are also supported.

### 2.3.1. Test Communications (Telnet Loopback)

A wireless link can be tested by connecting to the specific IP address and port number.

**Test a Wireless Link (Telnet Connection):**

1. Follow steps in the "Ethernet RF Modem Discovery" section [p9].
2. Setup hardware as shown in the 'Hardware Setup for Loopback Test' section of previous page [Figure 2-06].
3. If using Windows: Select (Start ' Run); then type "cmd" (without quotation marks) in the text box of the "Run" dialog box. Then select the 'OK' button.

   If using Linux or UNIX: Run a command shell.

   If using Mac OS X: Run (Applications ' Utilities ' Terminal).

[Remaining steps are for Microsoft Windows users]

4. At the command prompt, type: telnet xxx.xxx.xxx.xxx 14001 <CR>

   ("xxx.xxx.xxx.xxx" is the IP address of the Ethernet RF Modem, "14001" is the port number and "<CR>" stands for carriage return or 'Enter' key.) [Figure 2-08]
5. Begin typing characters into the Telnet session window [Figure 2-09].
   --> Characters typed should be echoed back to the screen. With each character typed, the "Data Out" and "Data In" LEDs should flash briefly on each of the PKG RF Modems.

   The wireless link can be double-checked by turning off the XTend-PKG-R RS-232/485 RF Modem (leaving the PKG-E Ethernet RF Modem on) and sending characters. When the PKG-R is turned off, characters should not be echoed back.

**Figure 2-08. Telnet Interface (connect to PKG-E having an IP address of 192.168.0.168)**

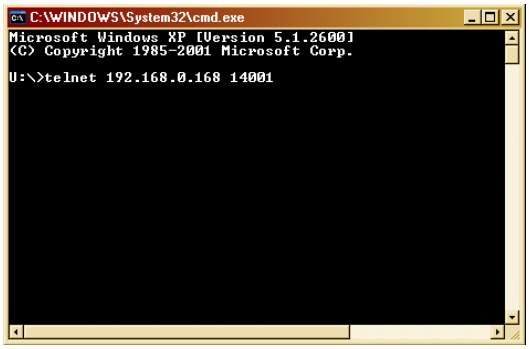



**Figure 2-09. Telnet Interface (Sent & Echoed back characters)**

# 3. RF Modem Operation

WARNING: When operating at 1 Watt power output, observe a minimum separation distance of 2' (0.6m) between modems. Transmitting in close proximity of other modems can damage modem front ends.

## 3.1. Serial Communications

### 3.1.1. Transparent Operation

By default, XTend RF Modems operate in Transparent Mode. The modems act as a serial line replacement - all UART data received through the DI pin is queued up for RF transmission. When RF data is received, the data is sent out the DO pin.

When the RO (Packetization Timeout) parameter threshold is satisfied, the modem attempts to initialize an RF transmission. If the modem cannot immediately transmit (for instance, if it is already receiving RF data), the serial data continues to be stored in the DI Buffer. Data is packetized and sent at any RO timeout or when the maximum packet size is received.

The modem operates as described above unless the Command Mode Sequence is detected. The Command Mode Sequence consists of three copies of the command sequence character [CC parameter] surrounded by the before and after guard times [BT & AT parameters].

If the DI buffer becomes full, hardware or software flow control must be implemented in order to prevent overflow (loss of data between the host and modem).

### 3.1.2. API Operation

API (Application Programming Interface) Operation is an alternative to the default Transparent Operation. The API is frame-based and extends the level to which a host application can interact with the networking capabilities of the module. When in API mode, all data entering and leaving the RF modem is contained in frames that define operations or events within the modem.

Transmit Data Frames (received through the DI (Data In) pin) include:

- 16-bit address

Receive Data Frames (sent out the DO (Data Out) pin) include:

- Showing a received RF packet (16 bits only)
- Response to a TX (Transmit) packet
- Showing events such as hardware reset, watchdog reset, asynchronous events, etc.

The modem will send data frames to the application containing status packets; as well as source, RSSI and payload information from received data packets.

API operation option facilitates many operations such as the examples cited below:

-> Change destination addresses without having to enter command mode
-> Receive success/failure status of each RF packet
-> Identify the source address of each received packet

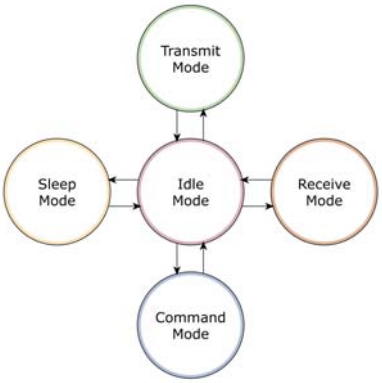
To implement API operations, refer to 'API Operation' sections [p42].

## 3.2. Modes of Operation

XTend RF Modems operate in five modes.

**Figure 3-01. Modes of Operation**




### 3.2.1. Idle Mode

When not receiving or transmitting data, the RF modem is in Idle Mode. The modem shifts into the other modes of operation under the following conditions:

- Transmit Mode (Serial data is received in the DI Buffer)
- Receive Mode (Valid RF data is received through the antenna)
- Sleep Mode (Sleep Mode condition is met)
- Command Mode (Command Mode Sequence is issued)

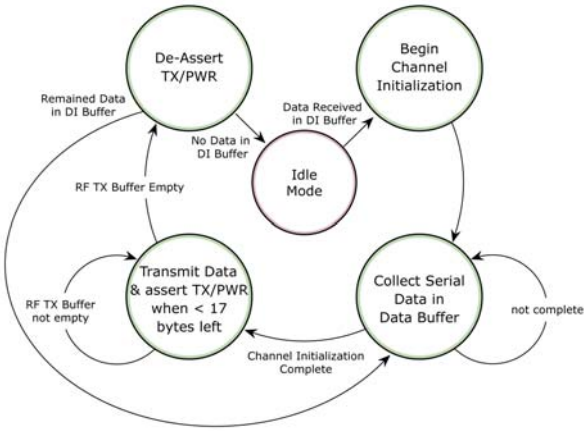
### 3.2.2. Transmit Mode

When the first byte of serial data is received from the UART in the DI buffer, the modem attempts to shift to Transmit Mode and initiate an RF connection with other modems. After transmission is complete, the modem returns to Idle Mode.

**RF transmission begins after either of the following criteria is met:**

1. RB bytes have been received by the UART and are pending for RF transmission. [Refer to the RB (Packetization Threshold) Command]
2. At least one character has been received by the UART and is pending for RF transmission; and RO character times of silence been observed on the UART. [Refer to the RO (Packetization Timeout) Command]

**Figure 3-02. Transmit Mode Data Flow**




The character timeout trigger can be disabled by setting RO to zero. In this case, transmission will not begin until RB bytes have been received and are pending for RF transmission. The RB parameter may be set to any value between 1 and the RF packet size [refer to PK (Max RF Packet Size) parameter], inclusive. Note that transition to Transmit Mode cannot take place during RF reception; the RF reception must complete before the radio can transition into Transmit Mode.

If RB or RO conditions are met, the modem initializes a communications channel. Serial data in the DI buffer is grouped into RF packets (up to 2048 bytes in each packet, refer to PK Command), converted to RF data and is transmitted over-the-air until the DI buffer is empty.

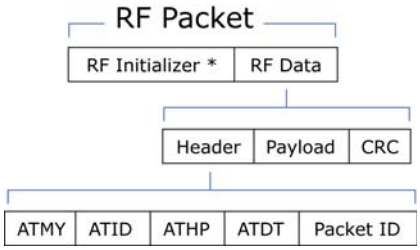
Channel initialization is the process of sending an RF initializer that synchronizes receiving modems with the transmitting modem. During channel initialization, incoming serial data accumulates in the DI buffer.

RF data, which includes the payload data, follows the RF initializer. The payload includes up to the maximum packet size (PK Command) bytes. As the TX modem nears the end of the transmission, it inspects the DI buffer to see if more data exists to be transmitted. This could be the case if more than PK bytes were originally pending in the DI buffer or if more bytes arrived from the UART after the transmission began. If more data is pending, the transmitting modem assembles a subsequent packet for transmission.

Refer to the 'RF Communication Modes' section to view state diagrams that illustrate channel initialization and the sequence of events that follow.

## RF Packet

**Figure 3-03. RF Packet Components**




* When streaming multiple RF packets, the RF Initializer is only sent in front of the first packet.

### RF Initializer

An RF initializer is sent each time a new connection sequence begins. The RF initializer contains channel information that notifies receiving modems of information such as the hopping pattern used by the transmitting modem. The first transmission always sends an RF initializer.

An RF initializer can be of various lengths depending on the amount of time determined to be required to prepare a receiving modem. For example, a wake-up initializer is a type of RF initializer used to wake remote modems from Sleep Mode (Refer to the FH, LH, HT and SM Commands for more information). The length of the wake-up initializer should be longer than the length of time remote modems are in cyclic sleep.

### Header

The header contains network addressing information that filters incoming RF data. The receiving modem checks for matching a Hopping Channel, VID and Destination Address. Data that does not pass through all three network filter layers is discarded.

Refer to the 'Addressing' section of the "RF Communication Modes" chapter for more information.

### CRC (Cyclic Redundancy Check)

To verify data integrity and provide built-in error checking, a 16-bit CRC (Cyclic Redundancy Check) is computed for the transmitted data and attached to the end of each RF packet. On the receiving end, the receiving modem computes the CRC on all incoming RF data. Received data that has an invalid CRC is discarded [refer to the 'Receive Mode' section].

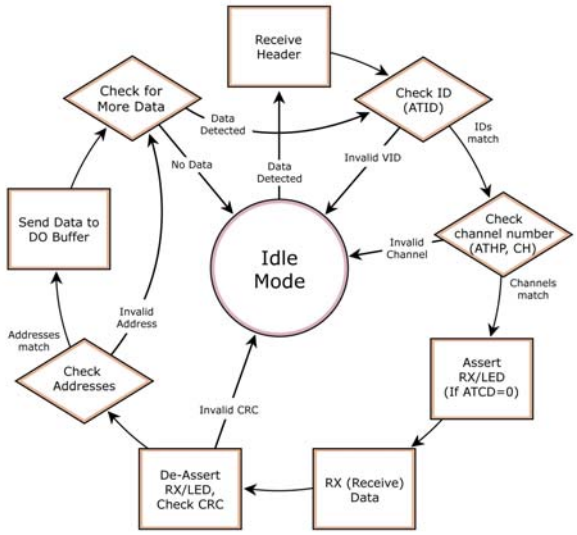
  

### 3.2.3. Receive Mode

If a modem detects RF data while operating in Idle Mode, the modem transitions to Receive Mode to start receiving RF packets. Once a packet is received, the modem checks the CRC (cyclic redundancy check) to ensure that the data was transmitted without error. If the CRC data bits on the incoming packet are invalid, the packet is discarded. If the CRC is valid, the packet proceeds to the DO Buffer.

**Figure 3-04. Receive Mode Data Flow**

* Refer to the 'Address Recognition' section for more information regarding address recognition.




The modem returns to Idle Mode when valid RF data is no longer detected or after an error is detected in the received RF data. If serial data is stored in the DI buffer while the modem is in Receive Mode, the serial data will be transmitted after the modem is finished receiving data and returns to Idle Mode.

### 3.2.4. Sleep Mode

#### Software Sleep

Sleep Modes enable the modem to enter states of low-power consumption when not in use. Three software Sleep Modes are supported:

- Serial Port Sleep (Wake on Serial Port activity)
- Cyclic Sleep (Wake on RF activity)

In order to enter Sleep Mode, the following condition must be met (in addition to the modem having a non-zero SM parameter value):

| |
|---|
| The modem is idle (no data transmission or reception) for the amount of time defined by the ST (Time before Sleep) parameter. [NOTE: ST is only active when SM = 4-5.] |

When in Sleep Mode, the modem will not transmit or receive data until the modem first transitions to Idle Mode. All Sleep Modes are enabled and disabled using SM Command. Transitions into and out of Sleep Modes are triggered by various mechanisms as shown in the table below.

**Table 3-01. Summary of Sleep Mode Configurations**

| Sleep Mode (Setting) | Transition into Sleep Mode | Transition out of Sleep Mode (wake) | Related Commands | Power Consumption |
|---|---|---|---|---|
| Serial Port Sleep (SM = 2) | Automatic transition to Sleep Mode occurs after a user-defined period of inactivity (no transmitting or receiving of data).<br>Period of inactivity is defined by the ST (Time before Sleep) Command. | When a serial byte is received on the DI pin | (SM), ST | < 210 mA |
| Cyclic Sleep (SM = 4 - 8) | RF modem transitions in and out of Sleep Mode in cycles (user-selectable wake-up interval of time is set using the SM command). The cyclic sleep interval of time must be shorter than the interval of time that is defined by the LH (Wake-up Initializer TImer) command.<br>Note: The modem can be forced into Idle Mode using the SLEEP pin if the PW (Pin Wake-up) command is issued. | | (SM), ST, HT, LH, PW | < 210 - 224 mA when sleeping (SM=4, 1 sec., @120K baud) |

The SM (Sleep Mode) command is central to setting all Sleep Mode configurations. By default, Sleep Modes are disabled (SM = 0) and the modem remains in Idle/Receive Mode. When in this state, the modem remains constantly ready to respond to serial or RF activity.

**Serial Port Sleep (SM = 2)**

- Wake on serial port activity
- Typical power-down current: < 210 mA

Serial Port Sleep is a Sleep Mode in which the modem runs in a low power state until serial data is detected on the DI pin.

The period of time the modem sleeps is determined by ST (Time before Sleep) Command. Once a character is received through the DI pin, the modem returns to Idle Mode and is fully operational.

**Cyclic Sleep (SM = 4-8)**

- Typical Power-down Current: < 210 - 224 mA (when asleep)

Cyclic Sleep Modes allow modems to periodically wake and check for RF data. The modem wakes according to the times designated by the Cyclic sleep settings. If the modem detects a wake-up initializer during the time it is awake, the modem synchronizes with the transmitting modem and receives data after the wake-up initializer runs its duration. Otherwise, the modem returns to Sleep Mode and continues to cycle in and out of activity until a wake-up initializer is detected.

While the modem is in Cyclic Sleep Mode, $\overline{\text{CTS}}$ (GPO1) is de-asserted (high) to indicate that data should not be sent to the modem. When the modem awakens to listen for data, GPO1 is asserted and any data received on the DI Pin is transmitted. The PWR pin is also de-asserted (low) when the modem is in Cyclic Sleep Mode.

The modem remains in Sleep Mode for a user-defined period of time ranging from 0.5 seconds to 16 seconds (SM parameters 4 through 8). After this interval of time, the modem returns to Idle Mode and listens for a valid data packet for 100 ms. If the modem does not detect valid data (on any frequency), the modem returns to Sleep Mode. If valid data is detected, the modem transitions into Receive Mode and receives the incoming RF packets. The modem then returns to Sleep Mode after a period of inactivity determined by the ST "Time before Sleep" parameter.

The modem can also be configured to wake from cyclic sleep when the SLEEP pin is de-asserted. To configure a modem to operate in this manner, PW (Pin Wake-up) Command must be issued. Once the SLEEP pin is de-asserted, the modem is forced into Idle Mode and can begin transmitting or receiving data. It remains active until data is no longer detected for the period of time specified by the ST Command, at which point it resumes its low-power cyclic state.

**Cyclic Scanning**. Each RF transmission consists of an RF Initializer and payload. The RF initializer contains initialization information and all receiving modems must wake during the wake-up initializer portion of data transmission in order to be synchronized with the transmitting modem and receive the data.

---

The cyclic interval time defined by SM (Sleep Mode) Command must be shorter than the interval time defined by LH (Wake-up Initializer Timer).

---

### 3.2.5. Command Mode

To modify or read modem parameters, the modem must first enter into Command Mode (state in which incoming characters are interpreted as commands). Two command types are supported:

- AT Commands
- Binary Commands

For modified parameter values to persist in the modem registry, changes must be saved to non-volatile memory using the WR (Write) command. Otherwise, parameters are restored to previously saved values when the modem is powered off and then on again.

#### AT Command Mode

**To Enter AT Command Mode:**

1. Send the 3-character command sequence "+++" and observe guard times before and after the command characters. [refer to 'Default AT Command Mode Sequence' below.] The 'Terminal' tab (or other serial communications software) of the X-CTU Software can be used to enter the sequence.

   [OR]

2. Assert (low) the $\overline{\text{CONFIG}}$ pin and turn the power going to the modem off and back on (or pulse the $\overline{\text{SHDN}}$ pin).

   [If the modem is mounted to a MaxStream RS-232/485 Interface Board, the result can be achieved by pressing the configuration switch down for 2 seconds.]

Default AT Command Mode Sequence (for transition to Command Mode):

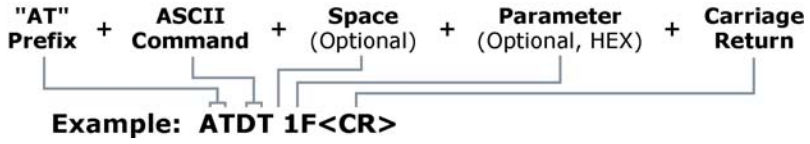
- No characters sent for one second [refer to the BT (Guard Time Before) Command]
- Input three plus characters ("+++") within one second
  [refer to the CC (Command Sequence Character) Command.]
- No characters sent for one second [refer to the AT (Guard Time After) Command.]

All of the parameter values in the sequence can be modified to reflect user preferences.

**To Send AT Commands:**

Send AT commands and parameters using the syntax shown below.

**Figure 3-05. Syntax for sending AT Commands**




To read a parameter value stored in the modem register, leave the parameter field blank.

The preceding example would change the modem's Destination Address to "0x1F". To store the new value to non-volatile (long term) memory, the Write (ATWR) command must subsequently be sent before powering off the modem.

**System Response.** When a command is sent to the modem, the modem will parse and execute the command. Upon successful execution of a command, the modem returns an "OK" message. If execution of a command results in an error, the modem returns an "ERROR" message.

**To Exit AT Command Mode:**

1. If no valid AT Commands are received within the time specified by CT (Command Mode Timeout) Command, the modem automatically returns to Idle Mode.

   [OR]

2. Send ATCN (Exit Command Mode) Command.

For an example of programming the RF modem using AT Commands and descriptions of each configurable parameter, refer to the "RF Modem Configuration" chapter [p20].

### Binary Command Mode

Sending and receiving parameter values using binary commands is the fastest way to change operating parameters of the modem. Binary commands are used most often to sample signal strength [refer to DB (Received Signal Strength) parameter] and/or error counts; or to change modem addresses and channels for polling systems when a quick response is necessary. Since the sending and receiving of parameter values takes place through the same serial data path as 'live' data (received RF payload), interference between the two types of data can be a concern.

Common questions about using binary commands:

- What are the implications of asserting CMD while live data is being sent or received?
- After sending serial data, is there a minimum time delay before CMD can be asserted?
- Is a time delay required after CMD is de-asserted before payload data can be sent?
- How does one discern between live data and data received in response to a command?

The CMD pin (GPI1) must be asserted in order to send binary commands to the modem. The CMD pin can be asserted to recognize binary commands anytime during the transmission or reception of data. The status of the CMD signal is only checked at the end of the stop bit as the byte is shifted into the serial port. The application does not allow control over when data is received, except by waiting for dead time between bursts of communication.

If the command is sent in the middle of a stream of payload data to be transmitted, the command will essentially be executed in the order it is received. If the modem is continuously receiving data, the radio will wait for a break in the received data before executing the command. The $\overline{\text{CTS}}$ signal will frame the response coming from the binary command request [refer to figure below].

A minimum time delay of 100 µs (after the stop bit of the command byte has been sent) must be observed before the CMD pin can be de-asserted. The command executes after all parameters associated with the command have been sent. If all parameters are not received within 0.5 seconds, the modem returns to Idle Mode.

Note: When parameters are sent, they are two bytes long with the least significant byte sent first. Binary commands that return one parameter byte must be written with two parameter bytes.

Commands can be queried for their current value by sending the command logically ORed (bitwise) with the value 0x80 (hexadecimal) with CMD asserted. When the binary value is sent (with no parameters), the current value of the command parameter is sent back through the DO pin.

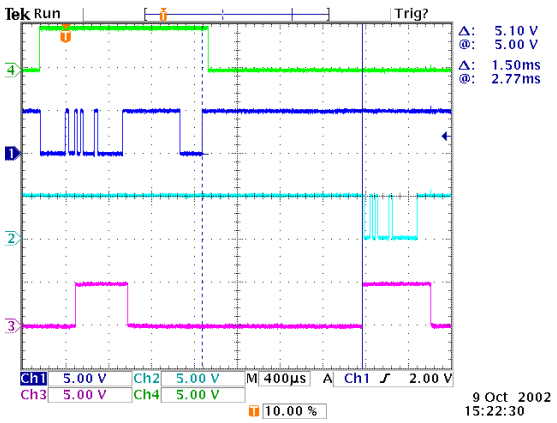
**Figure 3-06. Binary Command Write then Read**

Signal #4 is CMD

Signal #1 is the DI signal

Signal #2 is the DO signal from the radio

Signal #3 is $\overline{\text{CTS}}$




In this graph, a value was written to a register and then read out to verify it. While not in the middle of other received data, note that the $\overline{\text{CTS}}$ signal outlines the data response out of the modem.

IMPORTANT: In order for the modem to recognize a binary command, the RT (GPI1 Configuration) parameter must be set to one. If binary programming is not enabled (RT parameter value is not equal to '1'), the modem will not recognize that the CMD pin is asserted and therefore will not recognize the data as binary commands.

Refer to [p21] for a binary programming example (DT command example returns two bytes).

# 4. RF Modem Configuration

## 4.1. Programming Examples

Refer to the 'Command Mode' section [p18] for information regarding entrance into Command Mode, sending AT commands and exiting Command Mode.

Examples in this section cite the use of MaxStream's X-CTU Software for programming the RF modem. Other programs such as Telnet Software can also be used to program the modem.

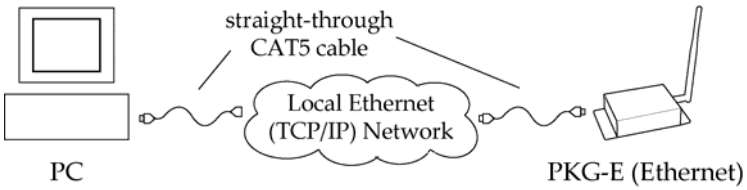
### 4.1.1. Configuration Setup Options

After installing the X-CTU and Com Port Redirector Software [p8] to a PC, use one of the connection options below to send commands to the XTend-PKG-E Ethernet RF Modem.

**Option # 1 - Local Network Connection**

Connect a PC and the Ethernet RF Modem to active Ethernet connections of the same local network [as shown in the figure below].

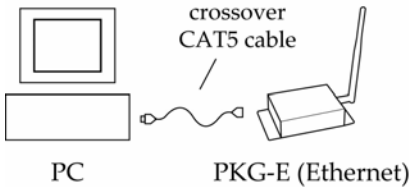
**Figure 4-01. Local Network Connection**




**Option # 2 - Direct PC Connection**

Connect the Ethernet RF Modem directly to the PC through the PC's Ethernet port [as shown in the figure below].

**Figure 4-02. Direct PC Connection**




**Configuration Setup:**

1. Install both the X-CTU Software and the Ethernet Com Port Redirector [See 'Install Software' [p8] section for more information].
2. Connect the Ethernet RF Modem to a PC using either a Local Network [Figure 4-01] or a Direct PC [Figure 4-02] connection.
3. Follow the steps outlined in the 'Ethernet RF Modem Discovery' section [p9] to identify the com port that will be used to configure the RF modem.
4. Launch the X-CTU Software on the PC and select the PC Settings tab.
5. Make sure values shown in the fields of the 'Com Port Setup' section match those of the Ethernet RF Modem.

[Example is continued on the following page.]

## 4.1.2. AT Command Examples

### Terminal Tab (X-CTU Software)

A terminal program has been built into the X-CTU software and is located under the 'Terminal' tab. The Terminal tab provides an easy-to-use interface for programming the modem.

**System Response.** When a command is sent to the modem, the modem will parse and execute the command. Upon successful execution of a command, the modem returns an "OK" message. If execution of a command results in an error, the modem returns an "ERROR" message.

**Restore RF Modem Default Parameters** (Using the 'Terminal' tab of the X-CTU Software)

Example: Both of the following examples restore the XTend Modem's factory defaults and save the parameters to non-volatile memory.

Method 1 (One line per command)

| Send AT Command | System Response |
|---|---|
| +++ | OK <CR> (Enter into Command Mode) |
| ATRE <Enter> | OK <CR> (Restore RF modem default parameter values) |
| ATWR <Enter> | OK <CR> (Write to non-volatile memory) |
| ATCN <Enter> | OK <CR> (Exit Command Mode) |

Method 2 (Multiple commands on one line)

| Send AT Command | System Response |
|---|---|
| +++ | OK <CR> (Enter into Command Mode) |
| ATRE, WR <Enter> | OK <CR> (Execute multiple commands) |
| ATCN <Enter> | OK (Exit AT Command Mode) |

Note: Do not send commands to the modem during flash programming (when parameters are being written to the modem registry).

Wait for the "OK" system response that follows the ATWR command before entering the next command or use flow control.

NOTE: Default parameter values of the RF Modem can also be restored by selecting the 'Restore' button located on the "Modem Configuration" tab [refer to the example below].

### Modem Configuration Tab

**Sample Configuration: Restore RF Modem Defaults**

Example: Utilize the X-CTU "Modem Configuration" tab to restore default parameter values.

After establishing a connection between the modem and a PC [refer to the 'Setup' section above], select the "Modem Configuration" tab of the X-CTU Software.

1. Select the 'Read' button.
2. Select the 'Restore' button.

## 4.1.3. Binary Command Example

**To Send Binary Commands:**

Example: Use binary commands to change the RF modem's destination address to 0x1A0D and save the new address to non-volatile memory.

1. RT Command must be set to '1' in AT Command Mode to enable binary programming.
2. Assert CMD (Pin 10 is driven high). (Enter Binary Command Mode)
3. Send Bytes [parameter bytes must be 2 bytes long]:
   - 00 (Send DT (Destination Address) Command)
   - 0D (Least significant byte of parameter bytes)
   - 1A (Most significant byte of parameter bytes)
   - 08 (Send WR (Write) Command)
4. De-assert CMD (GPI1 is driven low). (Exit Binary Command Mode)

Note: $\overline{\text{CTS}}$ (GPO1) is high when a command is being executed. Hardware flow control must be disabled as $\overline{\text{CTS}}$ will hold off parameter bytes.

## 4.2. Command Reference Table

**Table 4-01. XTend Commands** (The RF modems expect numerical values in hexadecimal. Hexadecimal values are designated by a "0x" prefix. Decimal equivalents are designated by a "d" suffix.)

| AT Command | Binary Command | AT Command Name | Parameter Range | Command Category | # Bytes Returned | Factory Default |
|---|---|---|---|---|---|---|
| %V | 0x3B (59d) | Board Voltage | 0x2CCCA - 0x5BFFA [read-only] | Diagnostics | 4 | -- |
| AM | 0x40 (64d) | Auto-set MY | -- | Networking & Security | -- | -- |
| AP v2.x20* | -- | API Enable | 0 - 2 | Serial Interfacing | 1 | 0 |
| AT | 0x05 (5d) | Guard Time After | 2 - (ATST-3) [x 100 msec] | Command Mode Options | 2 | 0x0A (10d) |
| BD | 0x15 (21d) | Interface Data Rate | 0 - 8 (standard rates)<br>0x39 - 0x1C9C38 (non-standard rates) | Serial Interfacing | 4 | 3 |
| BR | 0x39 (57d) | RF Data Rate | 0 - 1 | RF Interfacing | 1 | 1 |
| BT | 0x04 (4d) | Guard Time Before | 0 - 0xFFFF [x 100 msec] | Command Mode Options | 2 | 0x0A (10d) |
| CC | 0x13 (19d) | Command Sequence Character | 0x20 - 0x7F | Command Mode Options | 1 | 0x2B ["+"] (43d) |
| CD | 0x28 (40d) | GPO2 Configuration | 0 - 4 | Serial Interfacing | 1 | 2 |
| CF | -- | Number Base | 0 - 2 | Command Mode Options | 1 | 1 |
| CN | 0x09 (9d) | Exit Command Mode | -- | Command Mode Options | -- | -- |
| CS | 0x1F (31d) | GPO1 Configuration | 0 - 4 | Serial Interfacing | 1 | 0 |
| CT | 0x06 (6d) | Command Mode Timeout | 2 - 0xFFFF [x 100 ms] | Command Mode Options | 2 | 0xC8 (200d) |
| DB | 0x36 (54d) | Received Signal Strength | 0x6E - 0x28 [read-only] | Diagnostics | 2 | -- |
| DT | 0x00 (0d) | Destination Address | 0 - 0xFFFF | Networking & Security | 2 | 0 |
| E0 | 0x0A (10d) | Echo Off | -- | Command Mode Options | -- | -- |
| E1 | 0x0B (11d) | Echo On | -- | Command Mode Options | -- | -- |
| ER | 0x0F (15d) | Receive Error Count | 0 - 0xFFFF | Diagnostics | 2 | 0 |
| FH | 0x0D (13d) | Force Wake-up Initializer | -- | Sleep (Low Power) | -- | -- |
| FL | 0x07 (7d) | Software Flow Control | 0 - 1 | Serial Interfacing | 1 | 0 |
| FS | 0x3E (62d) | Forced Sync Time | 0 - 0xFFFF [x 10 msec] | RF Interfacing | 2 | 0 |
| FT | 0x24 (36d) | Flow Control Threshold | 0 - (DI buffer size - 0x11) [Bytes] | Serial Interfacing | 2 | DI buffer size minus 0x11 |
| GD | 0x10 (16d) | Receive Good Count | 0 - 0xFFFF | Diagnostics | 2 | 0 |
| HP | 0x11 (17d) | Hopping Channel | 0 - 9 | Networking & Security | 1 | 0 |
| HT | 0x03 (3d) | Time before Wake-up Initializer | 0 - 0xFFFF [x 100 msec] | Sleep (Low Power) | 2 | 0xFFFF (65535d) |
| HV | -- | Hardware Version | 0 - 0xFFFF [read-only] | Diagnostics | 2 | -- |
| ID | 0x27 (39d) | Modem VID | 0x11 - 0x7FFF (user-settable)<br>0x8000 - 0xFFFF (factory-set, read-only) | Networking & Security | 2 | 0x3332 (13106d) |
| KY | 0x3C (60d) | AES Encryption Key | 0 - (Any other 64-digit hex valid key) | Networking & Security | 2 | 0 |
| LH | 0x0C (12d) | Wake-up Initializer Timer | 0 - 0xFF [x 100 msec] | Sleep (Low Power) | 1 | 1 |
| MD v2.x20* | 0x31 (49d) | RF Mode | 0 - 6 | Networking & Security | 1 | 0 |
| MK | 0x12 (18d) | Address Mask | 0 - 0xFFFF | Networking & Security | 2 | 0xFFFF (65535d) |
| MT | 0x3D (61d) | Multi-Transmit | 0 - 0xFF | Networking & Security | 1 | 0 |
| MY | 0x2A (42d) | Source Address | 0 - 0xFFFF | Networking & Security | 2 | 0xFFFF (65535d) |
| NB | 0x23 (35d) | Parity | 0 - 4 | Serial Interfacing | 1 | 0 |
| PB v2.x20* | 0x45 (69d) | Polling Begin Address | 0 - 0xFFFF | Networking & Security | 2 | 0 |
| PD v2.x20* | 0x47 (71d) | Minimum Polling Delay | 0 - 0xFFFF<br>(Base: (x 1 ms), Remote: [x 10 ms]) | Networking & Security | 2 | 0 |
| PE v2.x20* | 0x46 (70d) | Polling End Address | 0 - 0xFFFF | Networking & Security | 2 | 0 |

**Table 4-01. XTend Commands** (The RF modems expect numerical values in hexadecimal. Hexadecimal values are designated by a "0x" prefix. Decimal equivalents are designated by a "d" suffix.)

| AT Command | Binary Command | AT Command Name | Parameter Range | Command Category | # Bytes Returned | Factory Default |
|---|---|---|---|---|---|---|
| PK | 0x29 (41d) | Maximum RF Packet Size | 1 - 0x800 [Bytes] | RF Interfacing | 2 | varies |
| PL | 0x3A (58d) | TX Power Level | 0 - 4 | RF Interfacing | 1 | 4 (1 Watt) |
| PW | 0x1D (29d) | Pin Wake-up | 0 - 1 | Sleep (Low Power) | 1 | 0 |
| RB | 0x20 (32d) | Packetization Threshold | 1 - Current value of PK | Serial Interfacing | 2 | 0x800 (2048d) |
| RC | -- | Ambient Power - Single Channel | 0 - 0x31 [dBm, read-only] | Diagnostics | 1 | -- |
| RE | 0x0E (14d) | Restore Defaults | -- | (Special) | -- | -- |
| RM | -- | Ambient Power - All Channels | No parameter - 0x7D0 | Diagnostics | 2 | -- |
| RN | 0x19 (25d) | Delay Slots | 0 - 0xFF [slots] | Networking & Security | 1 | 0 |
| RO | 0x21 (33d) | Packetization Timeout | 0 - 0xFFFF [x UART character time] | Serial Interfacing | 2 | 3 |
| RP | 0x22 (34d) | RSSI PWM Timer | 0 - 0xFF [x 100 msec] | Diagnostics | 1 | 0x20 (32d) |
| RR | 0x18 (24d) | Retries | 0 - 0xFF | Networking & Security | 1 | 0x0A (10d) |
| RT | 0x16 (22d) | GPI1 Configuration | 0 - 2 | Serial Interfacing | 1 | 0 |
| SB | 0x37 (55d) | Stop Bits | 0 - 1 | Serial Interfacing | 1 | 0 |
| SH | 0x25 (37d) | Serial Number High | 0 - 0xFFFF [read-only] | Diagnostics | 2 | varies |
| SL | 0x26 (38d) | Serial Number Low | 0 - 0xFFFF [read-only] | Diagnostics | 2 | varies |
| SM | 0x01 (1d) | Sleep Mode | 0 - 8 (3 is reserved) | Sleep (Low Power) | 1 | 0 |
| ST | 0x02 (2d) | Time before Sleep | (ATAT+3) - 0x7FFF [x 100 msec] | Sleep (Low Power) | 2 | 0x64 (100d) |
| TP | 0x38 (56d) | Board Temperature | 0 - 0x7F [read-only] | Diagnostics | 1 | -- |
| TR | 0x1B (27d) | Delivery Failure Count | 0 - 0xFFFF [read-only] | Diagnostics | 2 | 0 |
| TT | 0x1A (26d) | Streaming Limit | 0 - 0xFFFF [0 = disabled] | Networking & Security | 2 | 0 |
| TX | 0x3F (63d) | Transmit Only | 0 - 1 | RF Interfacing | 1 | 0 |
| VL | -- | Firmware Version - verbose | Returns string | Diagnostics | -- | -- |
| VR | 0x14 (20d) | Firmware Version | 0 - 0xFFFF [read-only] | Diagnostics | 2 | -- |
| WA | -- | Active Warning Numbers | Returns string | Diagnostics | -- | -- |
| WN | -- | Warning Data | Returns string | Diagnostics | -- | -- |
| WR | 0x08 (8d) | Write | -- | (Special) | -- | -- |
| WS | -- | Sticky Warning Numbers | Returns string | Diagnostics | -- | -- |

* Firmware version in which command and parameter options were first supported

## 4.3. Command Descriptions

Commands in this section are listed alphabetically. Command categories are designated between the "< >" symbols that follow each command title. By default, XTend RF Modems expect numerical values in hexadecimal since the default value of the CF (Number Base) Parameter is '1'. Hexadecimal values are designated by the "0x" prefix and decimal values by the "d" suffix.

### %V (Board Voltage) Command

<Diagnostics> %V Command is used to read the current voltage of the modem circuit board.

Sample Output:

5.02 V (when ATCF = 0)
5051F (when ATCF = 1) *
5.02 (when ATCF = 2)

* When CF = 1 (default), a hex integer is shown that is equal to (voltage * 65536d).

AT Command: AT%V

Binary Command: 0x3B (59 decimal)

Parameter Range (read-only):
0x2CCCA – 0x5BFFA
(2.80 – 5.75 decimal)

Number of bytes returned: 4

### AM (Auto-set MY) Command

<Networking & Security> AM Command is used to automatically set the MY (Source Address) parameter from the factory-set serial number of the modem. The address is formed with bits 29, 28 and 13-0 of the serial number (in that order). The resulting value is displayed as a result of this command.

AT Command: ATAM

Binary Command: 0x40 (64 decimal)

### AP (API Enable) Command

<Serial Interfacing> The AP command is used to enable the modem to operate using the frame-based API operation.

AT Command: ATAP

Parameter Range: 0 – 2

| Parameter | Configuration |
|---|---|
| 0 | API Disabled (Transparent Operation) |
| 1 | API enabled (w/out escaped characters) |
| 2 | API enabled (with escaped characters) |

Default Parameter Value:0

Number of Bytes Returned:1

Minimum Firmware Version Required: 2.x20

### AT (Guard Time After) Command

<Command Mode Options> AT Command is used to set/read the time-of-silence that follows the command sequence character (CC Command) of the AT Command Mode Sequence (BT + CC + AT). By default, 1 second must elapse before and after the command sequence character.

The times-of-silence surrounding the command sequence character are used to prevent inadvertent entrance into AT Command Mode.

AT Command: ATAT

Binary Command: 0x05 (5 decimal)

Parameter Range: 2 – (ATST-3), up to 0x7FFC [x 100 milliseconds]

Default Parameter Value: 0x0A (10 decimal)

Number of bytes returned: 2

Related Commands: BT (Guard Time Before), CC (Command Sequence Character)

### BD (Interface Data Rate) Command

<Serial Interfacing> The BD command is used to set and read the serial interface data rate (baud rate) used between the RF modem and host. This parameter determines the rate at which serial data is sent to the modem from the host. Modified interface data rates do not take effect until the CN (Exit AT Command Mode) command is issued and the system returns the 'OK' response.

When parameters 0-8 are sent to the modem, the respective interface data rates are used (as shown in the table on the right).

The RF data rate is not affected by the BD parameter. If the interface data rate is set higher than the RF data rate, a flow control configuration may need to be implemented.

The range between standard and non-standard baud rates (0x09 - 0x38) is invalid.

AT Command: ATBD

Binary Command: 0x15 (21 decimal)

Parameter Ranges: 0 – 8 (standard rates)
0x39 – 0x1C9C38 (non-standard rates)

| Parameter | Configuration (bps) |
|---|---|
| 0 | 1200 |
| 1 | 2400 |
| 2 | 4800 |
| 3 | 9600 |
| 4 | 19200 |
| 5 | 38400 |
| 6 | 57600 |
| 7 | 115200 |
| 8 | 230400 |

Default Parameter Value: 3

Non-standard baud rates supported as of firmware v2.x20

Number of bytes returned: 4

**Non-standard Interface Data Rates:**
Any value above 0x38 will be interpreted as an actual baud rate. When a value above 0x38 is sent, the closest interface data rate represented by the number is stored in the BD register. For example, a rate of 19200 bps can be set by sending the following command line "ATBD4B00". NOTE: When using MaxStream's X-CTU Software, non-standard interface data rates can only be set and read using the X-CTU 'Terminal' tab. Non-standard rates are not accessible through the 'Modem Configuration' tab.

When the BD command is sent with a non-standard interface data rate, the UART will adjust to accommodate the requested interface rate. In most cases, the clock resolution will cause the stored BD parameter to vary from the parameter that was sent (refer to the table below). Reading the BD command (send "ATBD" command without an associated parameter value) will return the value actually stored in the modem's BD register.

**Parameters Sent Versus Parameters Stored**

| BD Parameter Sent (HEX) | Interface Data Rate (bps) | BD Parameter Stored (HEX) |
|---|---|---|
| 0 | 1200 | 0 |
| 4 | 19,200 | 4 |
| 7 | 115,200 | 7 |
| 12C | 300 | 12B |
| 1C200 | 115,200 | 1B207 |

### BR (RF Data Rate) Command

<RF Interfacing> The BR command is used to set and read the RF data rate (rate that RF data is transmitted over-the-air) of the modem.

AT Command: ATBR

Binary Command: 0x39 (57 decimal)

Parameter Range: 0 – 1

| Parameter | Baud (bps) Configuration |
|---|---|
| 0 | 9600 |
| 1 | 115200 |

Default Parameter Value:1

Number of bytes returned: 1