

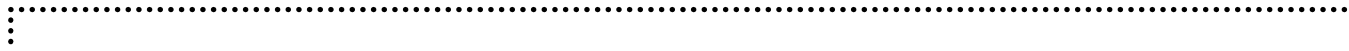


**Metricom**

# **RICOCHET MODEM REFERENCE GUIDE**

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**Patents**

This product covered by one or more of the following patents, other patents pending:

4,939,726	5,115,433
5,007,052	5,079,768
5,130,987	5,400,338
5,471,469	5,465,398
5,488,608	5,479,400
5,453,977	

**FCC Compliance**

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. These limits are designed to provide reasonable protection against harmful interference in a residential 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 safety measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Consult the dealer or an experienced modem technician for help.

**Export Restrictions**

Because the Ricochet modem incorporates strong encryption, its export is subject to restrictions imposed by the Arms Export Control Act and the U.S. Export Administration Act.

**Warranty**

Please refer to the limited warranty card in your Ricochet modem package.

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# INTRODUCTION

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This manual is intended for the user who wants to know more about how the Ricochet modem works. It contains a description of the Ricochet modem's more advanced configuration options. The manual also includes reference information for developers who are creating new applications using Ricochet modems.

Topics covered in this manual include:

- **Network Overview.** Your Ricochet modem is but one end point in a large network supporting Ricochet connections and services. “The Ricochet Network” reviews the components that make up the Ricochet Network and explains how they are used together to support your connections.
- **AT Command Descriptions.** The Ricochet modem is AT-compatible and can be configured with the same kinds of commands as you would use for a regular wired modem. AT commands let you set passwords, adjust the kinds of response codes the modem displays when you send it commands and much more. Read “Using Modem AT Commands” for information on AT command conventions and rules. In addition:
  - “The AT Command Set” includes a complete list of modem AT commands.
  - “Modem S Registers” contains a description of all configurable modem register settings.
- **Encryption.** Ricochet service lets you choose data encryption for the Radio Frequency portion of your connection. Read “Ricochet Encryption” to learn how this feature works.
- **Star Mode.** “Star Mode” is Ricochet’s connectionless communications service. This chapter explains what you need to know to develop Star Mode applications.

## *Notational Conventions*

---

The following command line conventions are used throughout this manual:

- Words in *<italics>* and angle brackets found in command lines are descriptive names for items you are to replace with the appropriate name or value. Do not enter the angle brackets.
- Words in bold are command names. When found in a command line, words in bold are required command line entries.
- Words or characters within square brackets ([ ]) are optional parts of a command line. If you make an entry for an option, do not type the brackets.

- A pipe character (|) means “or” in a command line.
- Words or characters in the `Courier` typeface indicate text that you might see on your terminal display.
- Neither the system prompt nor the command entry key is shown in command line examples.

# THE RICOCHET NETWORK

---

Metricom's Ricochet Network is a wide-area wireless data communications service. Ricochet subscribers make data connections from desktop, laptop and PDA (Personal Digital Assistant) devices via wireless modems to local area networks and a variety of regional, national and international networks. Subscribers to Metricom's Ricochet Network can access:

- The Internet
- Dial-up services (e.g., AOL, CompuServe, cc:Mail Mobile)
- Other modems (telephone line or other Ricochet modems)

Ricochet uses the license-free Part 15 Band at 902-928 Megahertz (MHz). Minimal power and transmitter duty cycles are used in the network to maintain high throughput and "neighbor friendly" operation. Metricom systems employ a robust radio and protocol design to maximize reliability.

## *Ricochet Network Overview*

---

The Ricochet Network combines the advantages of Metricom's high-speed wired network and the convenience and flexibility of a Radio Frequency (RF) network. It consists of a private Internet Protocol (IP)-based backbone network with connections to other networks and RF devices. Radios throughout a coverage area collect signals from Ricochet modems and pass them onto the wired backbone, where they are processed and passed through to connection service points.

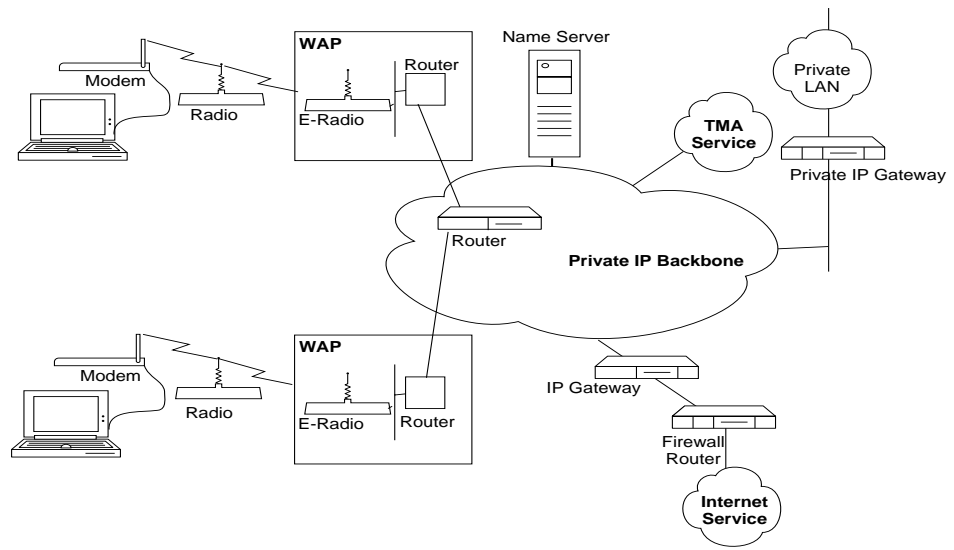


Figure 1. Overview of the Ricochet Network

### Ricochet Modems

Ricochet modems are AT-compatible modems which, instead of using a wired telephone network, make their connections using Radio Frequency. Users can make modem connections anywhere within a coverage area without having to have a dedicated telephone line connection between their Ricochet modem and the desired connection service. Ricochet modems also can communicate with other Ricochet modems on a peer-to-peer basis.

The Ricochet modem has two connectors, a serial port for computer connection and an AC adapter connector. Except for the cable used to connect it to the computer, the same Ricochet modem can be used with either a Personal Computer (PC) or a Macintosh computer.

### Network Radios

Network radios typically are installed on poletops throughout a geographic area. Radios form the mesh of the Ricochet Network, routing packets from radio to radio, funneling them onto the Metricom wired backbone network. Note that unlike Ricochet network radios, Ricochet modems do not perform radio packet routing functions.

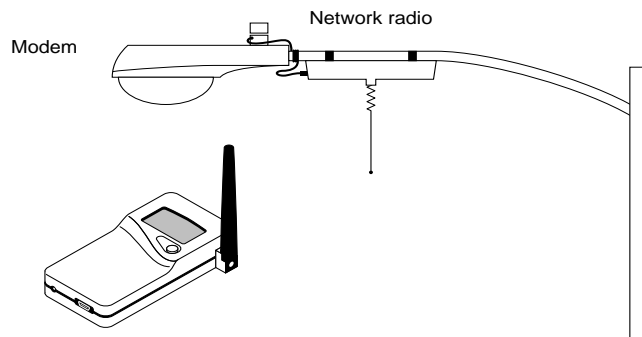


Figure 2. Ricochet Radios



### ***Ricochet Name Server***

The Name Server resides on the Metricom backbone and provides connection validation and path information to Ricochet modems. All connection requests go to the Name Server for authorization before a connection can be made.

The Name Server is integral to operating Ricochet's dial-up and Internet access services. When a Ricochet modem is first powered on, it sends a packet to the Name Server containing the Ricochet modem's serial number. The Name Server performs two functions: it validates the subscription and the service request. If either the subscriber serial number is invalid or the service being requested is not what the subscriber has purchased, the access request is denied. Only after the Ricochet modem successfully registers with the Name Server can the subscriber obtain Internet or phone-line service access on the Ricochet network.

Peer-to-peer operation does not require Name Server registration if the modems can "see" each other directly.

### ***Ricochet IP Gateways***

Gateways reside between the Metricom backbone network and the Internet. They provide connection services to the global Internet and other enterprise IP-based networks.

When packets are Internet-bound, they are routed to the IP Gateway, which transforms them into IP packets so they can be transmitted to hosts on the Internet.

### ***Telephone Bridges***

RF-to-phone line connections required for Ricochet's Telephone Modem Access (TMA) service are made using specially configured Ricochet modems. When a Ricochet modem is configured to operate in bridge mode, it translates signals from other Ricochet modems into signals that a standard wired modem can receive. Subscribers can set up their own personal TMA, too. This is discussed in the Ricochet User's Guide.

### ***Ricochet Ethernet Radio WAPs***

The Ethernet Radio operates just like other network radios, but includes Ethernet hardware and software capabilities. It can be installed directly onto an Ethernet network. Its Ethernet software capabilities convert RF network packets into a format for transmission over an IP-based network.

Banks of Ethernet Radios are installed at key locations—Wired Access Points (WAPs)—throughout the Ricochet Network. They pass RF signals from radios onto the Metricom wired backbone network. Radios are configured to send their incoming packets through a specific WAP, thereby reducing the number of "hops" an RF packet might take to reach the Metricom backbone network.

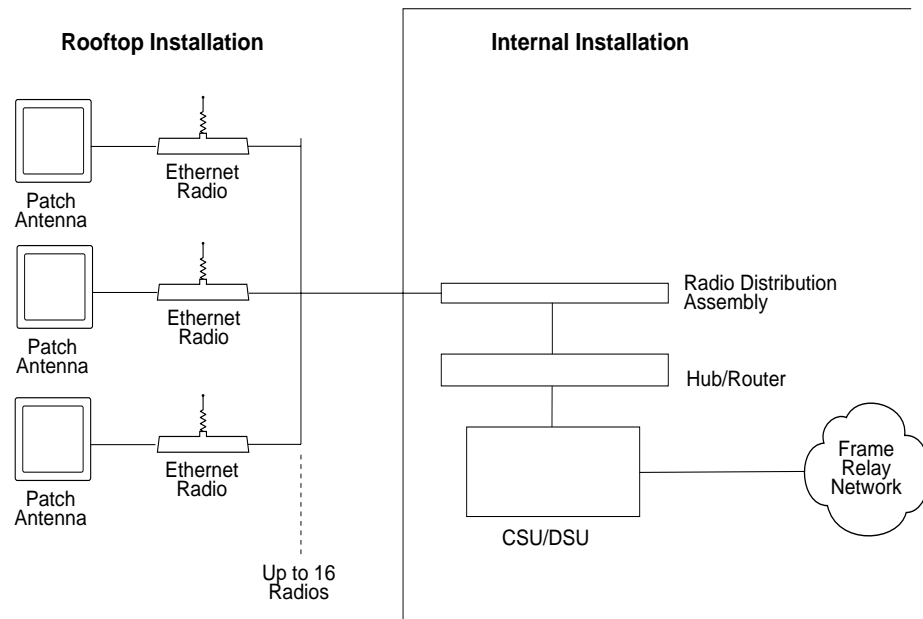


Figure 3. Typical Ethernet Radio WAP Site

Ethernet Radio WAPs consist, in part, of a rooftop installation with up to 16 Ethernet Radios. Inside the WAP site are the other WAP components—one distribution box for every eight radios, a hub/router and a CSU/DSU unit with connections to a T1-based Frame Relay network.

## Radio Network Operation

The following describes the operation of radios and Ricochet modems in the Ricochet Network.

### The “Mesh Network”

The Ricochet Network uses radios to form a “mesh network” architecture. This means that the network has a number of strategically placed radios in a given city or town whose combined coverage forms a mesh for routing radio packets over that geographic area.

Physically, Ricochet radios are very small compared to conventional cellular telephone base stations. They can easily be mounted to street light poles or on top of buildings and houses. These radios operate using a Gaussian Frequency Shift Keying (FSK) modulation scheme for baseband modulation. These radios employ 163 hopping channels with each using a different hopping sequence and phase. In the Ricochet Network data packets have a maximum length of 1183 bytes, and radios can forward packets at a data rate of 100 kilobits per second.

### Acquisition

Acquisition is a necessary first step for each radio on the network. Each radio or Ricochet modem must receive at least one packet from another Ricochet modem or a radio within range before it can send or receive packets through the network.

When a radio is powered on, it has no knowledge of any of its radio neighbors. It attempts to acquire neighboring radios (radios or Ricochet modems) by sending out packets where neighboring radios might be listening.

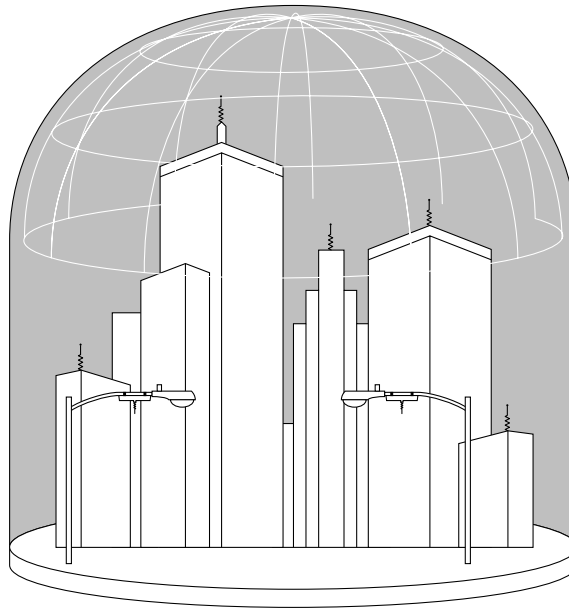


Figure 4. The Ricochet Network Mesh

Once it receives a packet from another radio, the information passed in that packet allows the radio to become a fully functional member of the mesh network.

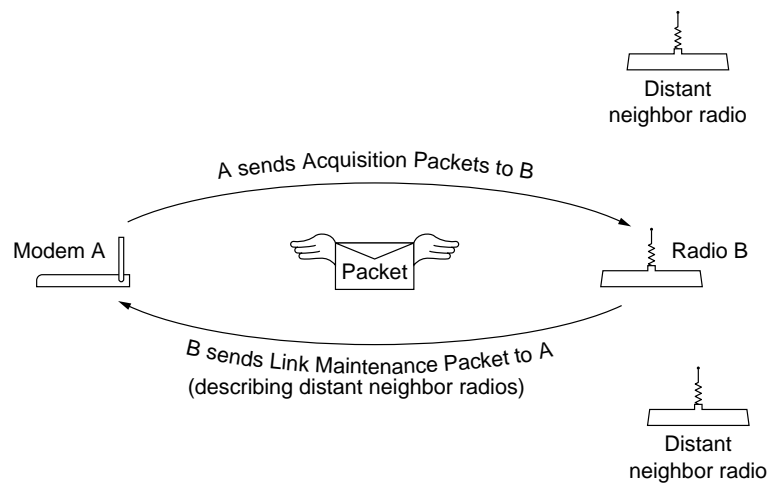


Figure 5. Sample Ricochet Modem Network Acquisition

Through the acquisition packet a radio learns the location and visibility of its neighboring radios and the location of neighboring Ricochet modems. When the Ricochet modem learns the location of the nearest radio it can use to communicate with the network, it will attempt to register through this “best node.”

The Ricochet modem sounds a two-tone beep (from low to high) when it has completed registration with the Name Server and verified a user’s Ricochet Service subscription. If the Ricochet modem does not sound a two-tone low-to-high beep, the modem has not registered with the Name Server. The Ricochet modem *can* perform peer-to-peer communication, however.

### **Operation**

When the Ricochet modem has received data from the radio, it uses the radio’s routing information to decide which radio to send a packet to. It polls the radio to see if it is able to accept a packet. Upon receiving an “Acknowledge” (ACK) packet from the radio, the Ricochet modem sends it its data packets. If it does not receive the “ACK” because another Ricochet modem already is communicating with the radio, the Ricochet modem simply tries another radio.

### **Packet Routing**

Radios have unique addresses—Wide Area Network (WAN) addresses—that reflect their geographic coordinates in latitude and longitude. During acquisition, radios provide their neighbors with their WAN addresses. Routing of packets through the network is greatly simplified through this addressing scheme because each radio knows where every other radio is located. In this way, packets are routed to radios progressively closer to the final destination.

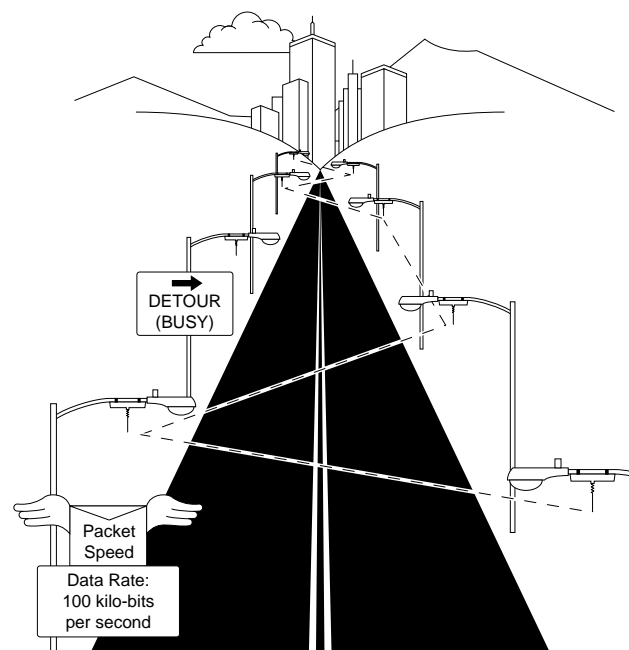


Figure 6. Ricochet Routing Scheme

The mesh network allows for alternate routing of packets should the next nearest radio be busy or out of operation. Consequently, each in a series of packets might take a very different route through the network.

Except for peer-to-peer Ricochet modem communications, all packets are funneled from the radio network onto the Metricom wired IP network. Here, subscriber service registration takes place and packets destined for Ricochet's services, such as the Internet and TMA, are routed to the appropriate service connection point. In addition, communication between geographically distant points in the radio network can take advantage of the high-speed packet transmission available on the wired network.

### ***Maintenance***

Each radio uses a different free-running clock as a timing reference. Since the radio's hopping sequence and phase information are essential for network operation, this information must be updated periodically, every half hour. The relative phases of the hopping sequences remain randomized over the network. Along with phase information, additional status data will be sent to ensure that the network continues to work in an efficient and error-free manner.

### ***How Network Connections Are Made***

Ricochet Network subscribers can use their modems to connect to:

- Ricochet's Internet service
- Telephone Modem Access (TMA) service
- Another Ricochet modem

Connection requests pass from the radio network to the Metricom IP network and onto the requested service.

A Ricochet modem gains access to the network by using the installed radio network to reach a Metricom IP network entry point, the WAP. After Name Server validation, a packet can take one of two paths, one bound for the Internet service and one for the TMA service. If the packet is bound for the Internet service, it is passed to a Ricochet IP Gateway. If the packet is bound for the TMA service, it is passed to a radio used for dial-up services.

### ***Internet Access***

Ricochet modems offer connections to the Internet, including the World Wide Web. The following diagram shows how a Ricochet modem connects to the Internet:

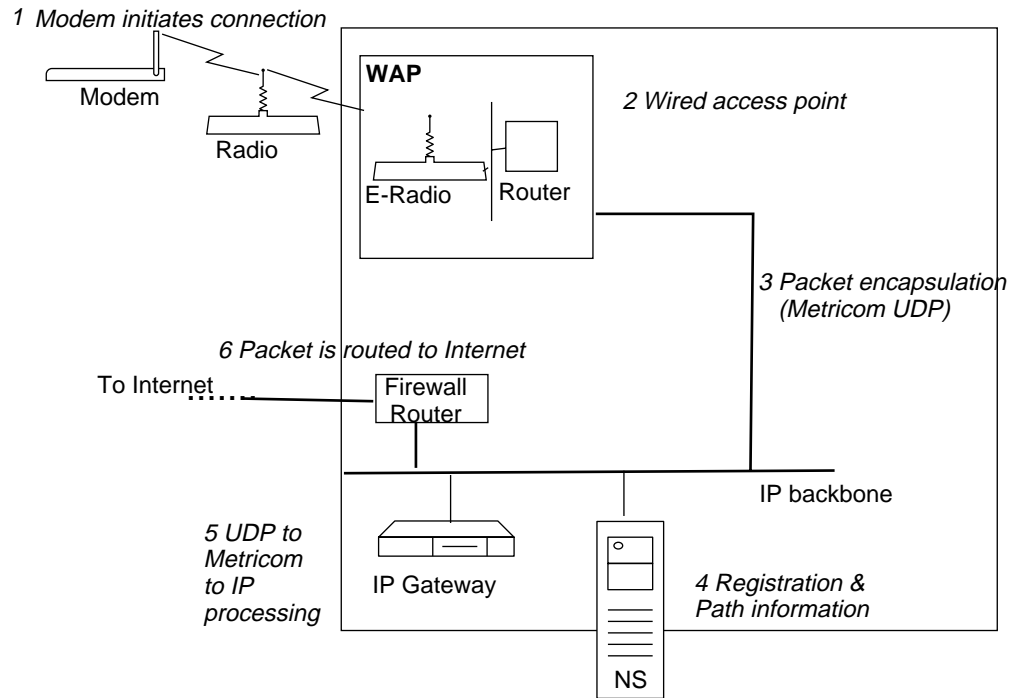


Figure 7. Internet Access Service Using the Ricochet IP Gateway

In the example, the modem accesses the Internet by the following steps:

1. Before a Ricochet modem sends an Internet connection request, it issues a lookup request for the Ricochet IP Gateway to the Name Server.
2. The Ricochet modem lookup request traverses the RF network, entering the Metricom backbone IP network through the WAP site.
3. At the WAP the RF packet is encapsulated for transmission over the Metricom IP network as a UDP packet to the Name Server.
4. The Name Server validates the subscriber and the services purchased by the subscriber. In its response, it also tells the Ricochet modem the path to take to access the Internet service. This path includes the address of the Ricochet IP Gateway to use.
5. The Ricochet modem then issues a request to connect to the IP gateway. Once the gateway responds to the modem's request, a virtual circuit is set up between the modem and the gateway.
6. The computer attached to the Ricochet modem issues a request to connect to an Internet host. The Ricochet modem forwards the packet to the WAP. Whereas the Ethernet radio encapsulates the packet in UDP and forwards it to the IP gateway, the gateway will turn the encapsulated UDP packet into a true IP packet. The IP packet is forwarded to a router that serves as a firewall to the Metricom IP network; from there the packet is forwarded to the target Internet host.

### TMA Service Access

Before subscribers can access the TMA service, their modems must be authenticated by the Name Server. After access is granted, RF packets from the Ricochet modem pass from a radio to a WAP before finally reaching the TMA service bridge to complete the connection to a target online service provider (such as AOL, CompuServe or a bulletin board). The following example illustrates the connection of Ricochet modem to the TMA service:

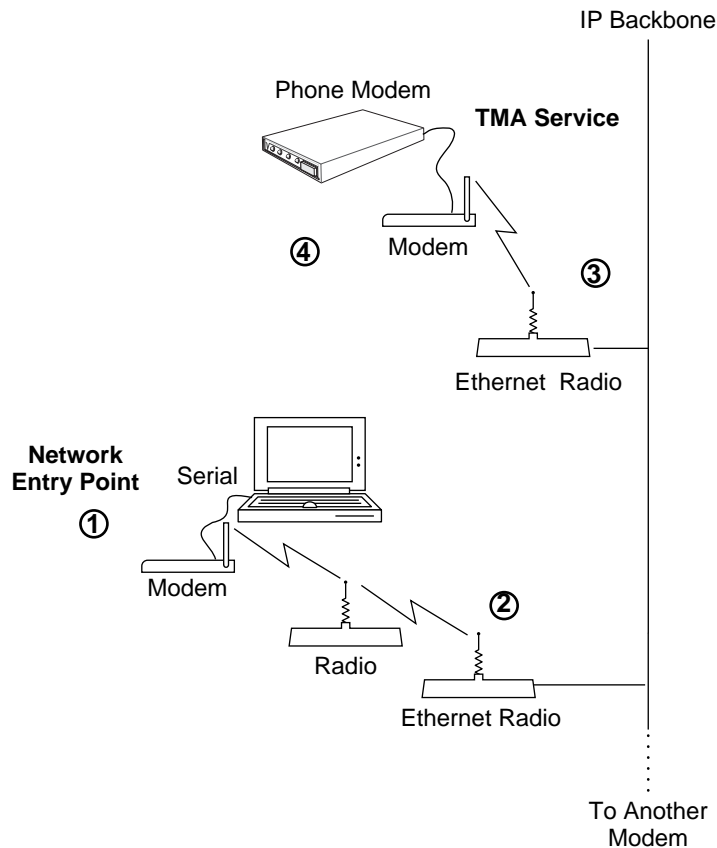


Figure 8. How TMA Service Connections Are Made

## Peer-to-Peer Access

Two Ricochet modems can establish connections with each other for peer-to-peer communication. Unlike Internet or TMA service access, peer-to-peer communication does not always require Name Server validation. The Ricochet modems can acquire each other directly if within about a quarter-mile RF range of each other. Peer-to-peer connections also may use RF-to-Metricom IP network paths, but only if the modems are subscribed with the Name Server and authorized to use the Metricom network.

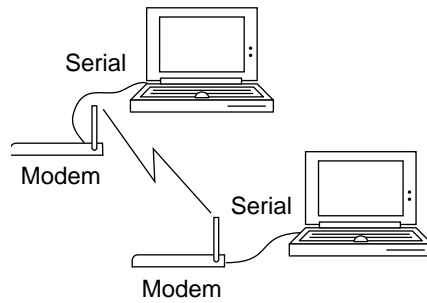


Figure 9. Peer-to-Peer Access Overview



# USING MODEM AT COMMANDS

---

Ricochet modems are configured with industry-standard AT (attention) commands. This chapter describes how to use the AT commands detailed in other parts of this reference guide.

To enter AT commands use a communications program installed on your computer. If you have a Windows-based computer, you can use Windows 95 HyperTerminal or Windows Terminal, which come with your operating system. Note that you can buy communications programs that let you choose options from menus, then translate your menu choices into AT commands.

## *Issuing Modem Commands*

---

When it is on, the Ricochet modem can be in one of three states:

- **Offline command state.** The modem is switched on but has not made a connection with another modem. You can give commands to the modem using your communications program.
- **Data state.** The modem is transmitting or receiving data. It won't accept commands.
- **Online command state.** The modem temporarily suspends data transmission so you can give it commands. Use the escape command +++ to put the modem into the online command state. To go back to the data state, type `ATO`. To hang up the connection and go to the offline command state, type `ATH`.

*NOTE: As you are entering the escape command sequence (+++), the characters will not be echoed. However, the modem will acknowledge the escape command with an "OK."*

## *Modem Command Syntax*

Modem commands have the following syntax:

- All commands begin with the "AT" prefix. This prefix must be written in all upper case letter (AT) or all lower case letters (at), but not in mixed cases (At or aT).
- The characters that follow "AT" can be any mixture of upper and lower case.
- All commands end with a carriage return (written as <cr>). Press the Enter (or Return) key after entering a command. This tells the modem to execute the command.
- Use the `A/` command to repeat the previous command.

**NOTE:** If commands do not appear on the computer's monitor as you type them, use the command **ATE1** to turn on local character echo ("ATE Command—Character Echo").

### **Writing Commands to Memory**

When you change the modem's settings, the change resides in the modem's dynamic memory. To save your changes to permanent memory, type the command **AT&W**. Otherwise, the next time you power cycle your modem, the modem will lose any changes you have made.

Note also that some changes don't go into effect until you have re-set your modem. To re-set your modem use the command **atz9**.

To combine both the write and reset commands, enter:

```
at&wz9
```

### **Result Codes**

When you issue a command, the modem displays a message or result code to indicate whether it understands and can act on the instructions (typically either OK or ERROR). Result codes also report the progress of a connection.

Several commands are used to control result code displays. These include **ATQ**, **ATV**, **ATW** and **ATX**. **ATQ** ("ATQ Command—Enable Result Codes") turns the result code displays on or off.

- If you prefer not to have the modem return result codes, or if the software you are using does not handle responses from the modem, use **ATQ** to turn them off.
- **ATV** ("ATV Command—Result Code Format") determines whether result codes are returned as numbers or as words.
- **ATW** ("ATW—Extended Result Code Support") turns on extended result code reporting, which is particularly useful when verifying that Ricochet encryption is turned on.
- **ATX** ("") lets you select the set of result codes you want reported during call progress.

By default, the modem performs and reports full call progress monitoring (RING, NO CARRIER, NO DIAL TONE and BUSY). It also indicates the speed of the connection.

### **Command Parameters**

For most AT commands, you can select a numeric parameter that further defines the command. For example: **ATE1** turns on echo in the command state; **ATE0** turns it off.

When the modem receives a command without a parameter, it assumes the parameter to be 0 (zero). The commands **ATE** and **ATE0**, for example, are identical. In most cases, therefore, you can omit the zero when you type the command.

### **Setting S Register Values**

S Registers are information storage locations in the modem. You can use an AT command to set the value stored in an S Register (see also "Modem S Registers"). To display the current value of a register, type the **ATS** command followed by the number of the register and a question mark. For example:

```
ATS10?
```

Change the value of an S Register by typing AT~~S~~, followed by the register number, an equal sign and the new value. For example:

```
ATS10=13
```

Suppose, for example, you want to determine the value of S Register 10, change that value to 13 and then verify the change. Your commands and the modem's responses would look like this:

```
ATS10?
025
OK
ATS10=13
OK
ATS10?
013
OK
```

You may also group commands into one command line. For instance, the commands from the previous example could be entered as follows:

```
ATS10=13&w
```

Note that when grouping commands, sometimes a space between commands is required to allow the modem to distinguish a command from a value. For example:

```
ats341=as340=12
```

In this case, the value "as341=12" becomes the password value for S341. Instead, the commands should be entered as follows:

```
ats341=a s340=12
```

## Dialing Up Devices and Services

The modem can make a connection to:

- Another Ricochet modem
- A Ricochet service

When dialing up a Ricochet modem, you need to know its eight-digit modem number. This number can be found on the modem label. If the modem has been configured with a unique name, you can use that instead (the unique name is shown in the **ATS300?** command display).

Metricom provides Internet service access to both metropolitan-area subscribers as well as campuses. To dial up the metropolitan Ricochet Internet service, use "777" in your dial-up string. To access your campus-based Internet service, ask your local system administrator for the Internet service name to use in your dial string.

When dialing the Ricochet Network Telephone Modem Access (TMA) service, use the prefix "9" before the desired phone number to make a connection.

## Dial-Up String Syntax

The modem dial-up string syntax is as follows:

```
atdt <target>[**<mode>][*<option/parameter>][***<password>]
```

Where:

**atdt** is the modem dial-up command.

**target** is the device or service you are attempting to connect to: the modem number, modem unique name or Ricochet service name.

\*\*<mode> can be a transport protocol or an encryption mode, including: **heavy**, **light**, **ecl**, **ech**. See "ATS340—Connection Method" on page 39 for more details.

\*<option/parameter> can be a dial-up access IP protocol (PPP, SLIP or CSLIP), a TMA dial string or the dial-up string to the modem used in bridge mode.

\*\*\*<password> is the modem session password (See "ATS322—Connect Password" on page 38).

### Sample Dial Strings

**Internet Service Dial-Up Example.** The mode *light* and the option *PPP* are the dial-up defaults. These are already stored in S340, so the dial-up string can be simply:

```
atdt <Ricochet_IP_service_name>
```

For example, to dial up Ricochet's Internet service, enter:

```
atdt 777
```

To dial up Ricochet's Internet service using a SLIP connection, enter:

```
atdt 777*slip
```

This command requests a SLIP connection. Including SLIP in the dial-up string overrides the modem's default setting of "ppp" in S340.

**Campus Internet Dial-Up Example.** The following is an example of a campus-based Internet dial-up string using the format:

```
atdt <campus_IP_service_name>
```

The target campus service name is "acme1":

```
atdt acme1
```

A session password may be required. The following example includes the session password "wireless":

```
atdt acme1***wireless
```

If a session password had already been stored in S322, the password in the above example would override it.

**TMA Dial-Up Example:** The following shows the format for dialing a number using TMA:

```
atdt 91<area_code><phone_number>
```

For example:

```
atdt 914085551212
```

Where “9” is the TMA prefix, “1” is the long distance dialing string prefix (always include even when dialing a local number) and “4085551212” is the telephone number being dialed.

**Modem-to-Modem Dial-Up Example.** To dial another modem in a Ricochet modem-to-Ricochet modem connection, use the following format:

```
atdt <modem_number | unique_name>
```

For example:

```
atdt 0000-1234
```

**Telephone Bridge Dial-Up Example.** The following is the dial string format to dial up a modem configured as a telephone bridge (for personal TMA connections, see the Ricochet User’s Guide):

```
atdt <modem_number | unique_name>*<phone_number>
```

For example, if the bridge modem is 0000-1234 and the number to dial is 1-415-555-1212, you would enter:

```
atdt 0000-1234*14155551212
```



# THE AT COMMAND SET

---

## ATA Command—Answer A Call Manually

ATA

This command is used to answer a call manually when the modem returns the RING result code.

## ATDT Command—Dial Connection

ATDT <target>[\*<mode>][\*<option/parameter>][\*\*\*<password>]

This command is used to dial or connect to Ricochet services or devices. See “Dial-Up String Syntax” for dial-up examples.

## ATE Command—Character Echo

ATE<0 | 1>

When enabled, character echo lets you see characters as you type them in.

ATE, ATE0 Disables character echo.

ATE1 Enables character echo (*default*).

## ATH Command—Hang Up

ATH

Hangs up (disconnects) an established connection. When the connection is terminated, NO CARRIER is displayed.

## ATI Command—Product Information

ATI<0 | 1 | 4>

Displays product information.

ATI, ATIO Requests product identification code.

ATI1 Returns checksum of firmware revision.

ATI4 Returns extended product identification. For example:

```
ati4
```

```
MCDN 106165-210 (UP-)
```

This display includes the operating software part number and the software version number (e.g., 210). For details, see the “Modem Banner” description.

**ATO Command—Return to Online Data State**

ATO

Returns the modem to the data state if the modem had been in the offline mode.

**ATQ Command—Enable Result Codes**

ATQ&lt;0 | 1&gt;

Controls the modem's handling of result codes.

ATQ, ATQ0 Enables result codes (*default*).

ATQ1 Disables result codes.

**ATS Command—Display/Configure S Registers**

Manages S Register(s).

ATS&lt;reg&gt;=&lt;value&gt; Sets S Register &lt;register\_number&gt; to &lt;value&gt;.

ATS&lt;reg&gt;? Displays the current value of the specified S Register &lt;reg&gt;.

ATS?! Displays all configurable Ricochet-specific S Registers.

ATS? Displays the last register accessed.

ATS=&lt;value&gt; Sets the last register accessed to the value specified.

**ATV Command—Result Code Format**

Result codes are returned by the modem to your modem application in the process of opening and closing connections. After you turn on result codes with the ATQ command, use the ATV command to return codes in the form of numbers or words (see “Numeric and Verbose Outputs”):

ATV, ATV0 Displays result messages as numbers.

ATV1 Displays result messages as words (*default*).**ATW—Extended Result Code Support**ATW0 Disables extended result codes (*default*).

ATW1 Enables extended result codes.

***Extended Result Displays During an Encrypted Session***

Used in combination, the ATV and the ATW commands allow you to turn on extended result codes that indicate whether encryption has been turned on for your connection.

See the following table for a description of how these command settings can affect the result codes you see. With verbose displays (ATV1) and extended messages (ATW1) turned on, the message, “/RSA” will be appended to encrypted connect messages; with numeric displays (ATV0) and extended messages (ATW1) turned on, the numeric encrypted connect result display will be 32 higher than when encryption is not used, as indicated in the following table:

Table 1. Numeric and Verbose Outputs



Not Extended (ATW0) (Default)		Extended (ATW1)		Description
Numeric Output (ATV0)	Verbose Output (ATV1) (Default)	Numeric Output (ATV0)	Verbose Output (ATV1)	
0	OK	0	OK	Command executed
1	CONNECT	33	CONNECT/RSA	Connection established
2	RING	2	RING	Ring signal detected
3	NO CARRIER	3	NO CARRIER	Carrier signal not detected or lost
4	ERROR	4	ERROR	Invalid command, error in command line
5	CONNECT 1200	37	CONNECT 1200/RSA	Connection established at 1200 baud
6	NO DIAL TONE	6	NO DIAL TONE	Dial tone not detected
7	BUSY	7	BUSY	The other modem is busy
8	NO ANSWER	8	NO ANSWER	The other modem is not there or is not answering.
10	CONNECT 2400	42	CONNECT 2400/RSA	Connection established at 2400 baud
11	CONNECT 4800	43	CONNECT 4800/RSA	Connection established at 4800 baud
12	CONNECT 9600	44	CONNECT 9600/RSA	Connection established at 9600 baud
14	CONNECT 19200	46	CONNECT 19200/RSA	Connection established at 19200 baud
16	CONNECT 38400	48	CONNECT 38400/RSA	Connection established at 38400 baud
17	CONNECT 14400	49	CONNECT 14400/RSA	Connection established at 14400 baud
21	CONNECT 28800	53	CONNECT 28800/RSA	Connection established at 28800 baud
19	CONNECT 57600	51	CONNECT 57600/RSA	Connection established at 57600 baud
22	CONNECT 115200	54	CONNECT 115200/RSA	Connection established at 115200 baud

**ATX Command—Result Code Range**

Defines the range of result codes you can get. The default is to return all available results.

Value	Result Codes	Description
ATX0	0–4	No DIAL TONE, BUSY or CONNECT XXXX
ATX1	0–5, 10–54	Get CONNECT XXXX (different values for different baud rates), no DIAL TONE or BUSY
ATX2	0–6, 10–54	DIAL TONE and CONNECT XXXX detected, no BUSY
ATX3	0–5, 7, 10–54	BUSY and CONNECT XXXX detected, no DIAL TONE
ATX4	0–7, 10–54	DIAL TONE, CONNECT XXXX and BUSY detected ( <i>default</i> )

Refer to Table 1 for a list of the available result codes.

**ATZ Command—Reset Modem**

Performs either a soft or hard reset. A soft reset restores configuration and all S Registers to values stored in non-volatile memory. A hard reset power cycles the modem and resets configuration from non-volatile memory.

**ATZ, ATZ0** Restores configuration to values stored in non-volatile memory.

**ATZ9** Restarts the modem (performs a hard reset).

**ATZ8 Command—Force Sleep Mode****ATZ8**

*NOTE: Sleep mode is only available for modems using battery power. You cannot force a modem plugged into AC power to sleep.*

*NOTE: Ricochet SE modems do not support this command.*

This command forces a battery-powered modem immediately into sleep mode. Turning on sleep mode allows you to save battery usage when the modem is turned on but not in use. The modem will then remain in sleep mode until it is reawakened when you press the modem's power button or by serial line activity as configured in register S326. See "ATS326—System Inactivity." See also "ATS327—Sleep Mode."

*NOTE: Note that you cannot use ATZ8 to put the modem to sleep when ATS327 is set to disable sleep mode.*

**AT&C Command—DCD Handling**

Specifies how the modem controls Data Carrier Detect (DCD).

**AT&C, AT&C0** DCD is always on (*default*).

**AT&C1** DCD is on when the modem is connected to another modem or gateway.

**AT&D Command—DTR Handling**

**AT&D <1 | 2| 3>**

Specifies what the modem should do if Data Terminal Ready (DTR) goes to a low state while the modem is connected.

*NOTE: If AT&D is set to non-zero and DTR is not present, the modem will not connect.*

**Star Mode:** When the modem is set to the default (ignore DTR), changes in DTR state do not affect Star Mode operation. However, if the modem is set for a non-default setting, the modem will not enter Star Mode unless DTR is high and any DTR transition to low will cause Star Mode to exit.

**AT&D, AT&D0** DTR ignored (*default*).

**AT&D1** The modem acts as if it received the escape (+++) command when DTR goes to the low state.

**AT&D2** The modem acts as if it received the disconnect (ATH) command when DTR goes to the low state.

**AT&D3** The modem acts as if it received the reset (ATZ) command when DTR goes to the low state.

**AT&F Command—Reset Configuration**

Sets the user-configurable parameters to factory levels. The following parameters are returned to their default values with this command:

- Ring (ATS0=0)
- Escape character (ATS2=43)
- CR character (ATS3=13)
- LF character (ATS4=10)
- Backspace character (ATS5=8)
- Connect timeout (ATS7=60 sec)

**AT&I Command—Industrial Mode Diagnostics**

This command allows you to display information about packet activity when the modem is set for Industrial Mode. Its options include:

**at&i, at&i0** View packet activity

**at&i1** View Industrial Mode MIB parameters

For example:

```

at&i0

LastDst: xxx.john_test
LastSrc: 00.00.84.00.0x.ff
LastTxMsg      (  1):  2b 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
LastRxMsg      (  8):  61 73 64 66 6a 6b 6c 3b 00 00 00 00 00 00 00 00
LastTxMsgTossed (  0):  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
LastRxMsgTossed (  0):  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

OK

```

This display includes the following fields:

**Table 2. AT&I Field Descriptions**

Field	Definition
LastDst	The name of the last modem the data was sent to
LastSrc	MAC address of last modem the data was received from
LastTxMsg	Up to first 16 bytes transmitted in the last message. The count is the number of bytes in the first packet of the last message.
LastRxMsg	Up to first 16 bytes received in the last message. The count is the number of bytes in the first packet of the last message.
LastTxMsgTossed	Up to first 16 bytes transmitted in the last message. The count is the number of bytes in the first packet of the last message for the last message that was attempted but couldn't be sent.
LastRxMsgTossed	Up to first 16 bytes transmitted in the last message. The count is the number of bytes in the first packet of the last message for the last message that failed to collate properly.

The following command lets you display Industrial Mode MIB parameters:

**at&i1**

```
TxMsgs          0 TxMsgBytes          0
  RxMsgs        0 RxMsgBytes          0
  TxPkts        0 RxPkts              0
  TxMsgsTossed  0 TxMsgTossedBytes    0
  RxMsgsTossed  0 RxMsgTossedBytes    0
  FailedNameLookups 0
```

OK

The field definitions are as follows:

**Table 3. AT&I1 Field Descriptions**

Field	Description
TxMsgs	The number of industrial messages transmitted
TxMsgBytes	Number of bytes transmitted
RxMsgs	The number of industrial messages received
RxMsgBytes	Number of bytes received
TxPkts	The number of industrial packets transmitted
RxPkts	The number of industrial packets received
TxMsgsTossed	The number of transmitted industrial messages tossed
TxMsgTossedBytes	The number of bytes of transmitted messages tossed
RxMsgsTossed	The number of received industrial messages tossed
RxMsgTossedBytes	The number of bytes of received messages tossed
FailedNameLookups	The number of failed name lookups

**AT&K Command—Flow Control**

Sets local flow control.

AT&K, AT&K0 Hardware flow control off

AT&K2, AT&K4 XON/XOFF (SE only)

AT&K3 RTS/CTS flow control (*default*)

**AT&N Command—Acquire Portable Nodes**

Lets you enable or disable the acquisition and maintenance of portable nodes. It may be turned on where Ricochet modems are used to make peer-to-peer connections.

AT&N, AT&N0 Portable acquisition off (*default*).

AT&N1 Portable acquisition on.

*IMPORTANT:* Do not use this command unless specifically advised to do so by Ricochet Customer Support.

**AT&V Command—Display S Register Values**

Displays the values of the lower 32 S Registers.

**AT&V**

```
S00:000 S01:000 S02:02b S03:00d S04:00a S05:008 S06:000 S07:03c S08:000
S09:000 S10:000 S11:000 S12:000 S13:000 S14:000 S15:000 S16:000 S17:000
S18:000 S19:000 S20:000 S21:000 S22:000 S23:000 S24:000 S25:000 S26:000
S27:000 S28:000 S29:000 S30:000 S31:000
```

See “Modem S Registers” for a complete list of AT-compatible registers that are used by the modem.

**AT&W Command—Save Configuration to NVRAM**

Stores the current configuration and S Registers to non-volatile random access memory (NVRAM). Use this command if you want to save a change you have made to the modem’s configuration. Otherwise, the modem will revert to the previous setting the next time you turn on your modem.

**AT-B Command—Bridge Mode**

AT-B<0 | 1 | 3 | 5 | 7>

Configures the modem as a bridge. The modem can then interface with a phone modem. For more information on using bridge mode, see the Ricochet User’s Guide.

AT-B0 Normal (non-bridging) operation. If the modem is configured as a bridge, then this option resets the bridge for normal, non-bridging operation.

AT-B1 Dedicated line mode. Configures the bridge modem to operate on systems that have access to dedicated lines. This puts the modem into a bridge mode that does not dial when a client connects to it. When a client attempts to connect to it, it will assert DCD and wait for DTR to be asserted. If this happens, then it will return CONNECT to the client. If it does not detect DTR within the number of seconds specified by S Register 7 then it will return NO CARRIER.

- AT-B3** Default mode. Configures the bridge modem to dial the string entered by the user (see “Dial-Up String Syntax”). This command causes the bridge modem to assert DCD and then dial the user supplied phone number. It will then wait for DTR to be asserted before returning CONNECT. If it does not detect DTR within the number of seconds specified by S Register 7 then it will return NO CARRIER.
- AT-B5** Pre-configured phone number. Configures the bridge modem to dial the string stored in register S804. This command causes the bridge modem to assert DCD before dialing the pre-configured number. It will then wait for DTR to be asserted before returning CONNECT. If it does not detect DTR within the number of seconds specified by S Register 7 then it will return NO CARRIER.
- AT-B7** Pre-configured prefix. Configures the bridge modem to dial the string stored in register S804 and then dial the user-supplied number. This command causes the bridge modem to assert DCD before it dials the number stored in register S804 and the user-supplied phone number. It will then wait for DTR to be asserted before returning CONNECT. If it does not detect DTR within the number of seconds specified by S Register 7 then it will return NO CARRIER.

See Also: “ATS800—Modem Control String,” “ATS802—Bridge Config/Auto-Start Options,” “ATS803—Phone Number Limit” and “ATS804—Phone Number/Dial String.”

**NOTE:** When the modem is in bridge mode, S Register 0 is ignored.

### **Hardware Required for Bridge Mode**

To configure a bridge you will need the following:

- A telephone modem
- Two Ricochet modems—one connected to your computer’s serial port and one to serve as the bridge between the modem and phone modem
- A Ricochet serial cable with a 9-pin female connector to connect the modem to the phone modem.

The Ricochet null modem cable is available through internal Metricom distribution or you may create your own. The following table shows how the pins on a Ricochet 9-pin connector must be routed for use in bridge configurations.

Bridge		Phone Modem	
Pin #	Signal	Pin #	Signal
1	DCD	4	DTR
2	RD	3	TD
3	TD	2	RD
4	DTR	1	DCD
5	Ground	5	Ground
6	DSR	-	No Connect

Bridge		Phone Modem	
Pin #	Signal	Pin #	Signal
7	RTS	8	CTS
8	CTS	7	RTS
9	<i>Unused</i>	9	<i>Unused</i>

### ***Configuring the Phone Modem***

The phone modem should be configured as follows:

- Hardware flow control is enabled
- The baud rate is set to match that of the bridge
- XON/XOFF is turned off





# MODEM S REGISTERS

---

## ATS0—Ring Register/Auto-Answer

This register specifies on which “telephone ring” the modem should answer and allow a connection. Since the modem is not a phone modem, it must simulate this. However, some applications expect the ring string to be generated when another modem is calling. Setting this register to 0 will disable the modem’s ability to answer a connect request from another modem. The modem will ring once and then wait. Setting this register to 1 tells it to answer on the first ring. The answer (ATA) command may then be used by the application to complete the connection. The range of values for this register is 0–3 (*default=0*).

*NOTE: This register is ignored when the modem is in bridge mode.*

## ATS2—Escape Character Sequence

S Register 2 sets the ASCII value of the escape character. The escape character sequence, +++, allows your modem to go from Data State to Offline Command State while maintaining the data connection with the remote modem. The escape character sequence is especially useful when you have established a data connection with a remote modem and want to check or change a setting of your modem and then return to sending data.

The default value (decimal 43) is equivalent to the ASCII character +. You can change this register to any value from 0 to 255 (*default=43*).

*NOTE: Set this value to 128 in a modem configured for bridge mode to disable the escape feature.*

## ATS3—Carriage Return

The ASCII value of the character that the modem will use to signify a carriage return. This character is used as a command line terminator and a result code terminator.

The default value (decimal 13) is equivalent to the ASCII character of the carriage return (end-of-line) character. You can change this register to any value from 0 to 255 (*default=13*).

## ATS4—Line Feed

S Register 4 sets the ASCII value of the line feed character. The default value is 10 in decimal and can be changed to any value from 0–127 (*default=10*).

### ATS5—Backspace

The ASCII value of the character that the modem will use to perform a backspace. The default value is decimal 8 and can be changed to any value from 0 and 32, or 127 (*default=8*).

### ATS7—Connect Attempt Timeout

S Register 7 tells your modem the maximum time (in seconds) to wait for a response from the receiving modem before hanging up and declaring failure (e.g., no dial tone, busy).

The default value is 60 seconds and can be changed to a number from 0 to 255. If your modem connects within the specified time, it sends a CONNECT response and enters the Online Data State. If it does not connect within the specified time, it sends a NO CARRIER response and returns to the Offline Command State (*default=60 sec*).

## Ricochet-Only S Registers

**NOTE:** Some of the Ricochet-only registers are read-only. If you try to write to a read-only register, a message indicating the register number and "ERROR" will be displayed.

Use the following command to view all configurable registers:

```
ats?!
300:Version          301:Serial #        304:Baud Rate
305:Numeric Name     306:Unique Name     310:Expected Links
311:Best Links       313:Max Data Size   314:ATA Timeout
316:Path Life        317:Path Cache Size 318:Net Timeout
319:Starmode Caps    320:Active Baud Rate 321:Ring Delay
322:Connect Password 323:User Inactivity  324:Starmode Tx Q
325:Battery Voltage  326:System Inactivity 327:Sleep Mode
328:OOB IP Addr      330:Service Password 1 331:Service Password 2
340:Connection Method 341:Encrypt Seed     342:Encrypt Key Length
343:Key Renegotiation 344:Gateway Key      360:Status Icons
361:Serial Lines      362:NS Attributes    370:Trans Rx Delay
371:Trans Tx Delay    372:Frame Length     373:Frame Offset
374:Frame Mask        380:RF Download      390:Mfrg Pn
391:R3 Date           392:R5 Date          393:Mfrg Pn Rev
```

OK

### ATS300—Version (Read Only)

This register contains the date the modem software was created, its serial number, its part number and its software version level. The following is the display for a modem with version 2.10 operating software:

```
ats300?
Ricochet RF Modem (UP-) -- (c) 1993-1997 Metricom Inc.
105884-210E Apr 16 1997 @ 11:32:34

Serial #: 00.20.b9.00.02.d6
Names: N:0000-0726 U:JaneDoe
Subnet 0.0.0.0, Network 3, Radios Acquired (5, 0)
```

Auto Baud, RS232 Lines: DTR RTS CTS DCD  
 Modem Config: &D0 &K3 M1 E1 V1 Q0 &C0 W0 X4 ~B0

Registered -- Last Lookup: No Errors

Refer to the following table for AT300? field descriptions.

**Table 4. AT300? Field Descriptions**

Field	Definition
Modem Banner	Contains the product name and copyright statement. The display also includes the following information about the modem's operating software: <ul style="list-style-type: none"> <li>■ The operating software level: U=User code</li> <li>■ The operating software type: P=Portable</li> </ul>
Part number-version level	This field gives the operating software part number which includes its version number.
Date & Time	These fields show the operating software creation time and the date.
Names	N = The Numeric Name (or Modem Number) is a unique, factory-set number (also found on the modem label). The Numeric Name must not match any other Numeric, Unique or Service Name. This number is represented by an ASCII string of no more than 11 characters: nnnn-nnnn (four decimal digits, a hyphen and four decimal digits) U = Unique name. A name which may be set by the customer. This name is represented by an ASCII string of no more than 31 characters. S = Service name. A non-unique name assigned to a gateway. Multiple modems or gateways may have the same service name. Connection requests are rolled over between the set of modems with the same names.
Subnet	Not used
Network	The network number this modem has access to, in this case, 3.
Radios Acquired	The number of radios acquired by the modem at start-up. The first number is the number of poletops; the second represents other modems.
Baud	The modem's serial line signaling configuration. Options include: Autobaud—In autobaud mode the modem automatically adapts to your computer's serial line data bit rate from 1200 to 57600 bps. Note that older modems only autobaud up to 38400. A manual baud rate selection for one of the following rates: 1200, 2400, 4800, 9600, 14400, 28800, 19200, 38400, 57600 or 115200. The modem will only understand data sent at the specified rate.
RS232 Lines	The current state of the modem's serial line. Values include: DTR (Data Terminal Ready) DCD (Data Carrier Detect) RTS (Ready Terminal Send) CTS (Clear to Send) MAC cable (only displayed for non-Phase I modems attached to Macintosh computers)

Field	Definition
Modem Config	<p>The default configuration is as follows:</p> <ul style="list-style-type: none"> <li>&amp;D0 = DTR Ignored</li> <li>&amp;K3 = RTS/CTS flow control</li> <li>M1 = Not used</li> <li>E1 = Enables character echo</li> <li>V1 = Returns verbose result codes</li> <li>Q0 = Enables result codes</li> <li>&amp;C0 = DCD is on</li> <li>W0 = Returns normal (non-extended) result codes</li> <li>X4 = Returns a complete set of result codes: DIAL TONE, CONNECT XXXX and BUSY</li> <li>-B0 = Normal (non-bridging) operation</li> </ul> <p><i>NOTE: The modem automatically detects whether the application at the other end of a modem connection requires parity to be turned on or not.</i></p>
Registration status	This line indicates whether the modem has been registered with the Name Server.

#### ATS301—Serial # (Read Only)

S Register 301 is used to read the Ricochet modem's unique serial number.

```
ATS301?
02.01.00.00.00.23
OK
```

#### ATS304—Baud Rate

This register contains the bits per second rate of the serial port. The S304 register is set to 0 by default, which means the modem is in autobaud mode. In autobaud mode the modem automatically adapts to your computer's serial line bit rate from 1200 to 57600 bps.

You may manually set the baud rate to any of the following: 1200, 2400, 4800, 9600, 14000, 28800, 19200, 38400, 57600 or 115200. The new baud rate change takes effect immediately (*default=0*).

#### ATS305—Numeric Name (Read Only)

S Register 305 contains the modem's unique modem ID. It should match the printed number found on the modem label. This register is read only.

```
ats305?
0000-5604
```

#### ATS306—Unique Name

S Register 306 lets you assign your modem a unique name. Other modem users can use the unique name to connect to your modem. However, it will default back to your original unique name the next time the modem establishes communications with the Ricochet Network. To permanently change your name, call Ricochet Customer Service.

**ATS310—Expected Links**

The number of radios that the modem should expect to acquire. As the number of radios your modem acquires approaches this number, the amount of effort the modem expends on acquisition diminishes. The value can be set from 1–255. For most locations, an expected link of 16 is sufficient for normal network usage. If you find that your modem does not acquire the network, then you may want to increase this S Register to see if a higher expected link value will help (*default=16*).

**ATS311—Best Links (Read Only)**

S Register 311 register displays up to ten best nodes that your modem has acquired in the Ricochet Network. They are sorted by received signal strength indicator (RSSI) in dBm, from strongest to weakest.

```

Lat: 37.250862 Long: -121.965065 Color: 29    29 -050
Lat: 37.250862 Long: -121.965065 Color: 29    31 -059
Lat: 37.249660 Long: -121.965665 Color: 0     17 -060
Lat: 37.250862 Long: -121.965065 Color: 29    17 -063
Lat: 37.248029 Long: -121.959915 Color: 0    141 -073
Lat: 37.252578 Long: -121.966953 Color: 0     16 -076

```

For example, the display will show you the latitude and longitude in decimal degrees of the radios you have acquired and their latency in microseconds, RSSI in dBm. The color is used to rate packets between radios with the same latitude and longitude.

**ATS313—Max Data Size (Read Only)**

The default value of the S Register 313 is 1183 bytes. This register displays the maximum data size used for a packet (*default=1183 bytes*).

**ATS314—ATA Timeout**

S Register 314 sets the amount of time the modem will wait for an ATA (answer) from the computer while in online command state. This S Register is used in conjunction with S0 register. For example, when S0=0 the modem will wait the specified timeout period for an ATA before returning No Answer to the calling modem. If S0 is not zero, this register will be ignored (*default=10 sec*).

**ATS316—Star Mode Path Life**

See "ATS316—Star Mode Path Life" on page 59.

**ATS317—Star Mode Path Cache Size**

See "ATS317—Star Mode Path Cache Size" on page 59.

**ATS318—Net Timeout (Keep Alive)**

This is the amount of idle time in minutes after which your modem will end a connection. The allowed range is 0–255 minutes. The target device in the connection must send a packet within the time set in this S Register or your modem will drop the connection. When set to 0, your modem will not idle out the connection (*default=0 min*).

**ATS319—Star Mode Configuration**

See "Star Mode Error Messages" on page 60.

**ATS320—Active Baud Rate (Read Only)**

This defines the active baud rate the Ricochet modem is using to talk through the serial port to the computer.

**ATS321—Ring Delay**

S Register 321 is the Ring Delay register used to control how much time to wait between the Ring and the Connect result codes. The S321 value is defined in increments of hundreds of milliseconds. This value can range from 0–255 (*default=1*).

**ATS322—Connect Password**

S Register 322 is the connection password. The password contained in this register must match that of the modem or gateway you are attempting to connect to. Valid characters for the connection password are any alphanumeric ASCII characters. The connect password is case-sensitive. By default there is no password which allows any modem to connect to your modem.

If you do not store the connect password here, you can include it in your dialing string. You must enter \*\*\* before the password in your dialing string. For example, if you are dialing up the Internet service, you might enter:

```
atdt 777***ricochet
```

In this example, 777 is the service you are dialing and *ricochet* is the connect password.

*NOTE: The connect password must contain only alphanumeric characters. No control characters or \*\*\* asterisk characters are allowed.*

If your S322 register value does not match the target's S322, NO CARRIER is returned unless the target S322 is empty, in which case everything matches (*default=none*).

**ATS323—User Inactivity**

This sets the minimum time (in seconds) that a connection can be silent (no data sent) before the connection times out. When two radios are connected, the timeout will be set to the lower of the two values for this parameter. The default is set to 0 (zero) seconds, which means that the connection will not time out. The range for this register is 0–65535 (*default=0 sec*).

**ATS324—Star Mode Tx Q**

See “ATS324—Starmode Tx Q” on page 59.

**ATS325—Battery Voltage (Read Only)**

This defines the current battery voltage of the Ricochet modem. The modem will start beeping (if sound is enabled) when the voltage drops below 5.75 Volts.

**ATS326—System Inactivity**

S Register 326 defines the amount of inactivity on the serial line in minutes before the modem goes into sleep mode. Configure a sleep mode using ATS327. A value of ATS326=0 means that the modem will not go into automatic sleep mode (*default=10 min*).

**ATS327—Sleep Mode**

This command is used to select an automatic sleep mode for a modem operating on battery power (a modem using AC power cannot be put into sleep mode). Use ATS326 to set the inactivity time.

When the modem sleeps, it is no longer part of the network. Upon wakeup, it will restart and reacquire the network. Applying AC power or pressing the power button will awaken the modem.

There are four different sleep mode options:

Value	Meaning
0	Disable sleep mode (default)
1	Enable sleep on no serial activity, wake-up on any activity on RX line.
2	Enable sleep on no serial activity, wake-up on DTR or RTS changing states from low to high.
3	Enable sleep on no serial activity, wake-up on activity on RX line or DTR or RTS changing states from low to high.
4	Enables light dozing on SE modems

When ATS327 is set to 0, you will not be able to use ATZ8 to manually force the modem to sleep (*default=0*).

*NOTE:* The modem will not go to sleep if a connection has been established.

**ATS330—Service Password 1****ATS331—Service Password 2**

The S330 and S331 passwords are used to prevent Ricochet Customer Support from remotely connecting to your Ricochet modem. You can change these registers if you don't want Ricochet Customer Support to remotely connect to your modem to help diagnose a problem. These are not used for normal operation of your modem (*default=0*).

**ATS340—Connection Method**

Use this register to specify a default connection mode and option. When you configure this register, the value you enter (*xy*) includes the mode as its first digit (*x*) and the option as its second digit (*y*). For example, to configure the encryption mode ecl over PPP, you would enter 42 into the register as follows:

```
ats340=42
```

To configure a lightweight connection over SLIP, you would enter:

```
ats340=11
```

The following table shows the values assigned to each mode and option:

Mode ( <i>x</i> )	Option ( <i>y</i> )
0=heavy	0=none
1=light	1=SLIP

Mode (x)	Option (y)
4=ecl	2=PPP
5=ech	

The connection mode stored in register S340 can be overridden in the modem dial-up string (*default=12; \*\*light\*PPP*).

Refer to the following to interpret the mode names:

*e* = use encryption

*c* = use the encryption seed stored in S341

*l* or *light* = use the lightweight protocol

*h* or *heavy* = use the heavyweight protocol

**Lightweight vs. Heavyweight.** The Ricochet modem supports two transport protocols, the Heavyweight Transport Protocol and the Lightweight Transport Protocol. These are modem protocols whose use depends on how reliable the underlying network is. The heavyweight protocol guarantees in-order, reliable packet delivery by performing error correction. Packets dropped due to unstable network conditions will be detected and re-sent. The lightweight protocol is equivalent to how a modem normally works, with noise; it guarantees in-order, best effort delivery of packets. When compared to the heavyweight protocol, it is much faster because it doesn't have the overhead that goes with guaranteeing packet transmission.

With the improved reliability of today's network applications, the Ricochet modem default has been changed to take advantage of the lightweight protocol's faster service. In most cases, the services provided by the heavyweight protocol are unnecessary and, in fact, redundant. On the other hand, if you know, for example, that you are in a coverage area with poor connectivity, see if your throughput improves by turning on the heavyweight protocol. Use S Register 340 to configure the protocol as required.

#### ATS341—Encryption Seed

S Register 341 stores an encryption seed value to be used with the encryption mode ecl. This value encrypts the modem's initial connection request. It must match at both ends of the connection.

The encryption seed can be up to eight ASCII characters in length. To enter a seed key value, use the following command:

```
ats341=<seed>
```

You will not be able to see the seed key value after you enter it. Be sure that the seed value is one that cannot be easily guessed. Metricom recommends mixing alphabetic characters with symbol characters. You can also mix spaces into the seed value.

When the target receives an encrypted connection request, it will turn on encryption. If the keys do not match (i.e., if the modem sends an encrypted connection request that the target cannot decipher), the target will not be able to complete the connection request. In this case, you will receive a "NO CARRIER" response (*default=none*).



**NOTE:** The seed is used only to calculate the key for the connection request. Thereafter, the key is changed using other algorithms embedded in the Ricochet software.

#### ATS342—Key Length

This S Register stores a value from 5 to 32 specifying a key length in bytes to be used to encrypt packets. The key length must match at both ends of a connection. For example, if encrypting a connection between two Ricochet modems, be sure to configure both with the same key length value or the connection request will fail.

Use the following command format to enter the desired value for this register (*default=32*):

```
ats342=<key length value>
```

#### ATS343—Negotiation Frequency

This register determines how often the session key will be renegotiated. This can be a value from 0 through 255 in hundreds of packets. When the specified number of packets have been sent, the key will be renegotiated. When set to 0 (zero), the key will not be renegotiated. Metricom strongly recommends that you do not turn this function off.

(*default=100*):

```
ats343=<number of packets between negotiations>
```

#### ATS360—Icon Status Register

This is a six-byte hexadecimal field showing the state of the status icons and bar graphs. Each icon is represented by two bits (four icons per byte). For each icon the states are defined as:

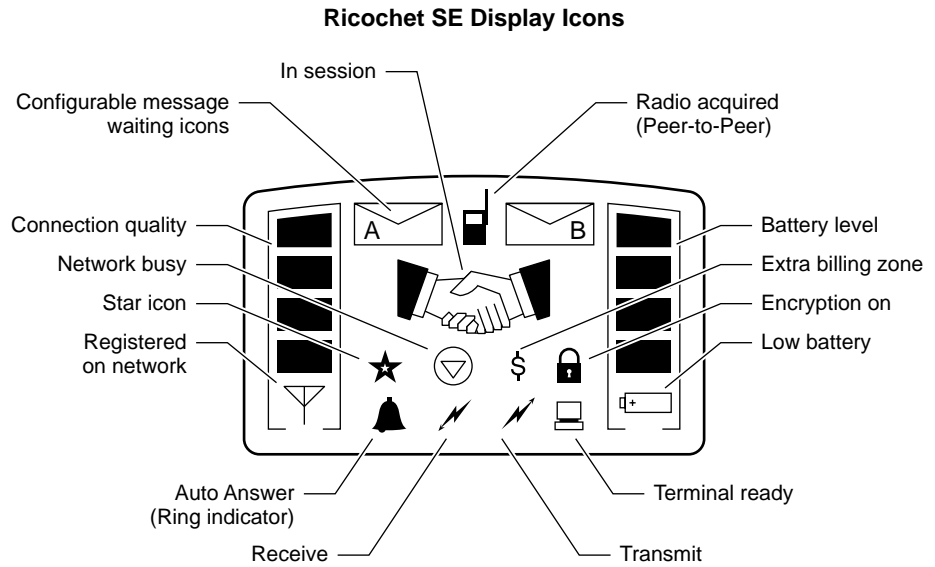
- 00 = Off
- 01 = Slow blink
- 10 = Fast blink
- 11 = On

Each bar graph is represented by 6 bits. The states are defined as follows:

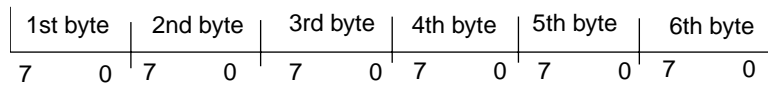
The lower four bits represent the segments which are on solid. For example, if the lower four bits were set to 0011, the bottom two segments would be on solid. The upper two bits represent the flash state of the non-solid segments corresponding to 0 values in the lower four bits.

The following flash states are supported:

- 00 = Off (not flashing)
- 01 = Pulsing slowly upwards



The table below shows the icons by byte. Refer to the following illustration for byte ordering:



Byte	Bits	Description
1	0-7	Reserved
2	0, 1 2, 3 4-7	Message waiting A Message waiting B Reserved
3	0-3 4, 5 6, 7	Signal strength bar Signal bar flash state Registered on network
4	0-3 4, 5 6, 7	Battery level bar strength bar Battery bar flash state Power on
5	0, 1 2, 3 4, 5 6, 7	Connected Come ready Auto-answer In range
6	0, 1 2, 3 4, 5 6, 7	Encryption Variable changes Network busy Star Mode

In most cases, the status bits are read-only. The values reflect the state of the display as determined internally by the modem. The exceptions are the message waiting icons. By setting `ATS360=0`, the message waiting icons are cleared. It is also possible to clear them selectively by writing a non-zero (hexadecimal) value which is used as a bitmask to be ended with the first 2 bytes of `S360`. For example, `ATS360=FFF3` would clear message waiting B and leave message waiting A intact, or `ATS360=FFFC` would clear message waiting A leaving B intact.

#### ATS361—Serial Status

This register is used to read the status of the modem's serial line.

Register Value	Meaning
0x01	Ring indicate
0x02	DCD
0x04	CTS
0x08	DSR
0x10	RTS
<i>SE Only:</i>	
0x40	BRIDGE
0x80	SEREN

#### ATS362—NS Attributes (Read Only)

The value in this register is controlled by the Name Server. This is a hexadecimal value with the following defined fields:

Register Value	Meaning
0x0001	Report to the Name Server when being connected to or disconnected from
0x0002	rdest read is disabled (this modem cannot initiate an rdest read)
0x0004	rdest write is disabled (this modem cannot initiate an rdest write)
0x0008	Modem is a desktop modem

If set for a desktop modem and it is not plugged into AC power, the modem will sit in low power mode. If AC is applied, it will reboot and start up again. If the desktop modem feature is deactivated, the modem must be running from AC to re-register with the Name Server to get the new setting.

#### ATS380—Remote Download

When this register is set to a non-zero value, the modem goes into RF download mode or reboot. This allows Metricom to download software upgrades to customer modems.  
(Default=0)

**ATS390—Mfrg Pn**

S Register 390 is a four-byte manufacturing part number, entered and displayed in decimal.

**ATS391—R3 Date**

**ATS392—R5 Date**

**ATS393—Mfrg Pn Rev**

These registers are used for manufacturing test purposes.

**ATS400—Boots (Read Only)**

This register shows the number of times the modem has been turned on or hard reset (*default=0*).

**ATS800—Modem Control String**

The bridge modem sends the contents of this S Register to the phone modem prior to dialing the phone number. The contents of this S Register are ignored when the bridge modem is in the dedicated line mode (AT~B1). The maximum length of this string is 15 characters (*default=ATX4&C1&D2*).

**ATS802—Bridge Config/Auto-Start Options**

This register controls two features: bridging mode (also specified with "AT~B Command—Bridge Mode" on page 29) and auto-start options.

You can use this register to turn bridge mode on and off and to specify dialing behavior while in bridge mode.

Auto-start can be used to have the modem automatically dial a connection when the modem boots or registers with the network. This mode is useful if you have to restart the modem and want to immediately re-dial your connection (*default=0*).

Hex Value	Bit	State	Description
<b>Bridge Configuration</b>			
0x00	0	0	Disable bridge mode
		1	Enable bridge mode
0x01	1, 2	00	Bridge will not dial
0x03		01	Bridge will dial user-supplied number
0x05		10	Bridge will dial local number
0x07		11	Bridge will prepend number to user-supplied number
	3		Don't care
<b>Auto-Start Setup</b>			
0x10	4	0	--
		1	Dial the value in S804 whenever DTR goes from high to low or the modem changes state and DTR is high

Hex Value	Bit	State	Description
0x20	5	0	--
		1	Dial the value in S804 whenever RTS goes from high to low or the modem changes state and RTS is high
0x40	6	0	--
		1	Dial up the value in S804 immediately upon booting
0x80	7	0	--
		1	Dial up the value in S804 upon registering with the network

**ATS802=00** Non-bridge mode (same as AT-B0). The modem is not in bridge mode.

**ATS802=01** Bridge will not dial (same as AT-B1). In this mode, the bridge will not dial the local number nor will it accept a user-supplied number. When a user connects to the bridge, the bridge will assert DTR and wait for DCD from the modem. This mode is often used for a direct connection where you toggle DTR to connect to the remote system.

**ATS802=03** Bridge dials user-supplied phone number (same as AT-B3). In this mode when a user connects to the bridge, the bridge will assert DTR and dial the user supplied phone number provided its length is less than that specified by S Register 803.

**ATS802=05** Bridge dials local phone number (same as AT-B5). In this mode when a user connects to the bridge, the bridge will assert DTR, dial the local phone number (S Register 804) and wait for the modem to respond with DCD.

**ATS802=07** Bridge prepends local number to user-supplied phone number (same as AT-B7). In this mode, when a user connects to the bridge, the bridge will assert DTR, dial the local phone number (S Register 804) followed by the user supplied phone number, provided its length is less than that specified by S Register 803.

**ATS802=10** Modem immediately dials the atdt dial string when DTR is high. In this mode the bridge dials the atdt command string stored in S Register 804 as soon as DTR is high or the modem state changes and DTR is high.

**ATS802=20** Modem immediately dials the atdt dial string when RTS is high. In this mode the bridge dials the atdt command string stored in S Register 804 as soon as RTS is high or the modem state changes and RTS is high.

**ATS802=40** Modem immediately dials the atdt dial string upon booting. In this mode as soon as the bridge has rebooted, it dials the atdt command string stored in S Register 804.

**ATS802=80** Modem immediately dials the atdt dial string upon acquiring network. In this mode the bridge dials the atdt command string stored in S Register 804 as soon as it acquires the network.

#### ATS803—Phone Number Limit

This is the maximum number of digits (or characters) that the bridge modem will accept in the user-supplied phone number. If the user passes a phone number that has more characters than is specified in this S Register, the bridge will not dial the number. Rather, it will hang up the connection.

This provides an easy way to limit the bridge modem to dialing local phone numbers (or extensions) only. Note that all characters after the "\*" until the first space are counted, including hyphens (-). The maximum value for this field is 255. This S Register is used when the bridge modem is in either "user-supplied phone number" (AT~B3) or "pre-configured prefix" (AT~B7) mode (*default=60*).

#### ATS804—Phone Number/Dial String

Use S Register 804 to configure a dial string to be used with either a bridge mode or auto-start mode. The maximum length of this string is 31 characters (*default=none*).

**Bridge Mode.** If the modem is in bridge mode and is set to dial a specific number (AT~B=5 mode) or to prepend some number (AT~B=7 mode) in front of a user-supplied phone number, use this register to specify the phone number or the prepend value.

In the AT~B=5 mode, you may want to provide access to only one application (like CompuServe, America On-line, corporate e-mail, etc.) or you may not want to risk other users making costly calls on your phone line. In this case, this register should be set to the entire phone number to be dialed. The bridge will dial that number only and not accept a user-entered dial string.

If a prefix is required for calls made through the bridge, configure the bridge for the AT~B=7 prepend information mode. You then will need only to pass a phone number in your dial string. The bridge will automatically add the prefix for you.

**Auto-Start Mode.** When this mode is selected in S Register 802, use this register to enter the value to be dialed. For example, to have the modem dial up Star Mode, enter:

```
ats804=atdt**starmode
```

# RICOCHET ENCRYPTION

---

Ricochet's encryption protects data sent over the Radio Frequency (RF) portion of your Ricochet Network connections. You can turn on encryption for all Ricochet Network connections, including connections:

- To the Ricochet Internet service
- To the Ricochet TMA service
- Between Ricochet modems (including connections to Ricochet modems (both operating with V2.03 or higher)

The following describes:

- How Ricochet encryption works
- Encryption mode options
- Modem S Registers used in encryption

*NOTE: Encryption is available on Ricochet SE and Original (Phase II) model modems. Encryption, however, is not supported on Phase I modems.*

## ***How Encryption Works***

Encryption is used to ensure privacy of information transmitted over connections between Ricochet modems and Ricochet Network access points. Encryption renders data unreadable by “scrambling” it using mathematical algorithms. It ensures privacy by keeping information hidden, even from those who can see the encrypted data.

A *key* is used to start the calculations that scramble data and unscramble it. The biggest challenge in an encrypted system is keeping the encryption key secret. During a Ricochet Network encrypted connection, the key is always changing.

## ***What Makes Ricochet Encryption Secure***

In a *single key* system, where both parties know and use the same key to encrypt and decrypt data, security can easily unravel if that one key becomes known.

Ricochet Network data encryption, on the other hand, implements a highly-secure public key system using the Diffie-Hellman method for key calculation and the RC4 packet encryption method for encrypting blocks of data. Whitfield Diffie and Martin Hellman invented a *two-key* system, employing a public key and a private key. The public key is published while the private key is kept secret. This is comparable to the key system banks use for a security box you might rent from them. The security box is locked and unlocked using two keys, one that the bank keeps (like a public key) and one that you alone have and keep (your private key).

This two-key system has been integrated into Ricochet encryption and operates transparently when you turn on the encryption option.

### *Seed Keys*

When you start an encrypted connection between your Ricochet modem and another Ricochet modem or the Ricochet Internet service, the first key that the modem uses to start an encrypted connection session is known as the “seed” key. If the keys do not match (i.e., if the modem sends an encrypted connection request that the target cannot decipher), the target will not be able to complete the connection request. Instead, you will receive the NO CARRIER response.

The seed key is only used at the start of an encrypted connection to protect the connection request and the first few packets until the initial key negotiation is complete (about one minute). Both the modem and the target use the seed key to create a new key (using Diffie-Hellman key renegotiation) and continue to recalculate new keys throughout your connection time. Key renegotiation is based on packet count. When a specific number of packets have been exchanged during the connection the key will be renegotiated.

Note that while inherently secure, the first minute of an encrypted session (until a new key is negotiated), is considered to be less so than the remainder of connection time. This is because its security depends heavily on the secrecy of your seed key. As a result, the longer the connection time, the more secure your data becomes.

### *Encryption Mode*

To request an encrypted connection, use the encryption mode `ecl` in your Ricochet dial string. The `ecl` mode can be used in the dial string or stored in the modem's register S340 (see “ATS340—Connection Method”). When it is stored in the modem, you won't need to specify the mode in the dial string.

The `ecl` mode bases its calculation of the encrypted connection's seed key on the value stored in S Register 341. For metropolitan-area Ricochet customers, encryption is available out of the box, using this register's default value. The seed key *must match* at both ends of the connection. Don't change this value unless you know the correct value to use. For campus-based users, use the value supplied by your campus network system administrator.

The encryption seed can be up to eight characters long (see “ATS341—Encryption Seed”).



.....

**NOTE:** A seed value must be a word or name that cannot be easily discovered or guessed at. It is best to mix numbers and symbols in a seed.

### ***Encrypting Ricochet Internet Service Connections***

**NOTE:** The `ecl` mode will not work for metropolitan service Internet connections if you change the default encryption seed setting in S341.

To use the `ecl` mode for Ricochet's Internet service, enter:

```
atdt 777**ecl
```

To specify a SLIP connection, use the following format:

```
atdt 777**ecl*SLIP
```

As a result, encryption is turned on between your modem and the Internet service device.

### ***Encrypting TMA Connections***

**NOTE:** The `ecl` mode will not work for metropolitan service TMA connections if you change the default encryption seed setting in S341.

To encrypt your connection when using the Ricochet TMA service, use the encryption mode `ecl` in your dial-up string using the following format:

```
atdt 9<phone_no.>**ecl
```

For example, to dial the number 800-123-4567 via TMA, enter:

```
atdt 98001234567**ecl
```

As a result, encryption is turned on between your modem and the TMA service device.

### ***Encrypting Modem-to-Modem Connections***

To make an encrypted connection between two Ricochet modems, use the `ecl` mode in the following format:

```
atdt <modem_ID>**ecl
```

For example:

```
atdt 0000-1234**ecl
```

As a result encryption is turned on between the two Ricochet modems.

Make sure that the user-settable encryption seed stored in S341 is configured into *both* modems.

### ***Encrypting Campus Internet Service Connections***

Corporate or university campuses offer Ricochet Network services via their own Ricochet IP Gateway. Campus users would use the following dial-up command format:

```
atdt <campus_IP_service_name>**ecl
```

For example:

```
atdt acmenet**ecl
```

Note that options are available to the campus administrator to tailor encryption. These include:

- Setting an encryption seed
- Regulating encryption parameters: key length and negotiation frequency

These values are stored in the modem S Registers. If encryption is offered at your site, find out from your campus administrator if you need to change the value for any of these parameters.

The administrator may also force encryption for all connections to the gateway. In this case, you must use the required parameters or your connection requests will fail.

### *Other Encryption Parameters*

In addition to selecting a mode and configuring seeds, you can set the following parameters:

- Key length
- Negotiation frequency

The key length specifies the size of the key to be used during the connection. The key length range is from 5 to 32 bytes (the default is 32 bytes). The key length must match at both ends of the connection. Do not change the key length unless you control both ends of the connection, i. e., don't change this value for metropolitan service Internet or TMA connections.

The negotiation frequency determines how often the key is renegotiated. This can be a value from 0 through 255 in hundreds of packets (the default is 100). When the specified number of packets has been sent, the key will be renegotiated.

### *S Registers Used for Encryption*

You will need to use a communications program to configure the modem (As an alternative, modem commands can also be sent via your modem application's modem initialization string). For more information about these S Registers, see the following descriptions:

- "ATS340—Connection Method"
- "ATS341—Encryption Seed"
- "ATS342—Key Length"
- "ATS343—Negotiation Frequency"

# STAR MODE

---

Star Mode is Metricom's connectionless datagram service. It features:

- Connectionless service for multiple, simultaneous user sessions
- AT commands from within Star Mode
- Handles—for visibility and communication with anonymous local modems

Star Mode allows applications to send data to multiple users without first needing to establish a connection. Any modem in Star Mode can talk to any other modem that is in Star Mode (privacy privileges excepted). Although you can type characters while in Star Mode, it was not designed for user input; it is intended for applications that can take advantage of (or require) connectionless communications.

Note that because Star Mode is connectionless, it comes with the following limitations:

*No re-ordering.* Since there is no connection between the sending and receiving modems, there is no guarantee that packets will arrive at their destination or that they will be in the same order as when they were transmitted. If ordering is required, your application must mark the data packets in such a way that the receiving modem can re-order them.

*No end-to-end acknowledgment.* Unlike the ATDT connection, which will retry and re-order packets automatically, Star Mode does not guarantee delivery. If such information is important, your application must have some way of determining whether the packet arrived at its destination (an ACK protocol),

## Overview

---

Star Mode is the Ricochet modem's exclusive, packet-building data mode. Only modems in Star Mode can send and receive Star Mode data. Packets are built based on data entered in Star Mode.

You can use binary or ASCII mode. The modem distinguishes the mode by looking for a *packet length specifier* (see below). If a packet length specifier is not present, the modem uses the ASCII mode.

### *Star Mode Syntax*

When a modem *sends* a Star Mode packet, it consists of:

- A destination
- An identifier

- A set of user data

When a modem *receives* a Star Mode packet, the packet consists of:

- The identifier
- The user data
- The address of the modem that sent the packet

An asterisk (\*) must precede and follow the destination, as shown below. When using ASCII mode, the packet comprises the following fields:

```
<CR>*<Destination>*<Identifier><User Data>
```

When using binary mode, the packet also includes the packet length specifier field:

```
<CR>*<Destination>~<length>*<Identifier><User Data>
```

The Star Mode packet your modem receives will be preceded by a <CR> and contain both asterisks, the identifier for the sending modem or application, the length specifier (if one was used to send the data) and the data:

```
<CR>*<Source>*<Identifier><User Data>
```

Note that you can further configure received packets using S Register 319 options. See “ATS319—Star Mode Configuration Register.”

The following details packet components:

Field	Description
Destination	<p>Indicates where the packet is to be sent. The destination can be one of the three IDs defined for Ricochet modems: modem number, unique name or service name (see the names description on page 35). It could also be a handle, a modem alias used in Star Mode to preserve privacy. See “Handles” described below.</p> <p>To issue AT commands to the modem itself, use the following destination name:</p> <p>*&amp;COMMAND*</p>
Source	<p>Indicates the source of the packet. The packet could come from another modem or from one of the following sources:</p> <p>*!MODEM*—A response to a modem AT command</p> <p>*!ACK*—An acknowledgment</p> <p>*!INFO*—An information message</p> <p>*!ERROR*—An error message</p>
~length	<p>The length of the packet in ASCII digits. <i>Note that the maximum packet length as defined in S Register 313 is 1183 bytes.</i> Do not attempt to use binary integer values here—use only the ASCII characters 0x30 through 0x39 (0–9) to represent the length. Note that the total length includes every byte after the second asterisk, so it must include the length of the &lt;Identifier&gt;. The length must be preceded by the tilde (~) sign.</p>

Field	Description
Identifier	<p>The unique four-digit ID of the application associated with the Star Mode data. If there are several applications running in a network, the modem must be able to determine that the incoming Star Mode packet is meant for its application. <i>Contact Metricom to receive a unique identifier for each of your applications.</i></p> <p>The following application IDs have been defined by Metricom for use with Star Mode:</p> <p>ERR_—Star Mode error messages</p> <p>INFO—Star Mode information messages</p> <p>ACK_—Star Mode acknowledgment messages</p> <p>METC—MetriChat application</p> <p>ATR—Modem command responses (the fourth digit is a space)</p>
User Data	The actual data that is sent to another modem.
<cr>	If using ASCII mode (no packet length specifier), the data must be terminated by the command line terminator. <i>The command line terminator (normally 0x0D or &lt;return&gt;) signals the end of the user data and causes the packet to be transmitted.</i>

### Handles

In addition to using a modem ID (such as 0000-0840, JOHN.DOE, or INFOSERVICE), Star Mode allows you to use *handles* to initiate a session with another modem without knowing its true ID. Handles are used specifically to preserve privacy (caller ID functions are implementable). Handles are derived from a unique value stored in each modem. Handles begin with the prefix &E followed by six to sixteen digits. For example:

```
&ECB8B4BF2EA0C
```

When your modem receives a packet from another modem whose identifier is a handle, your modem can use the handle for the destination in a response. Handles are limited to the current Star Mode session only—if you exit to AT command mode and re-enter Star Mode, all handles will change.

Handles also expire over time and only a limited number of handles are remembered at one time. This means that:

- You may want your software to embed user-identification (including modem name, if you wish) in the user data that travels in the Star Mode packet.
- If you have a session with more than six sources (see S Register 317 on page 59), handles will become invalid if the name cache fills. For example, suppose your modem has received a packet from handle &000101. Before replying, your modem also may have received ten or so packets from different sources. When your modem attempts to send a packet to &000101, you receive an error message. This means the cache entry for that handle has expired. You will not be able to contact that destination unless you know the modem name.

Although cache sizing adjustments may be made available in the future, they will not offer any scalability to hundreds of sources. The solution to both of these limitations is to include your modem's address in the user data portion of the Star Mode packet, so that your application can store the actual modem name and use it to return data anytime it is needed. If you are concerned about security, you may wish to encrypt the name and send it only in a single ACK'd packet.

### *Before Entering Star Mode*

Before entering Star Mode you should disable command echo (ate0). This makes parsing data from the modem much easier and more reliable. If command echo is on, then another Star Mode packet could arrive while a packet is being entered into the modem. The application will then find that the incoming Star Mode packet has been placed somewhere in the middle of the echoed data from the recently entered packet.

Once in Star Mode, you must specify the destination for each packet explicitly within the data.

### *Entering Star Mode*

When the modem is turned on, it comes up in command mode. Both normal AT commands as well as special Metricom commands can be used. To enter Star Mode from command mode, use the following command:

```
atdt**starmode
```

If you have echo character turned on (ate1), you will receive a prompt confirming the successful entry into Star Mode:

```
*>
```

*NOTE: The prompt will appear after each data packet has been sent. It will not appear after the receipt of a data packet.*

If character echo is turned off, you will receive neither a prompt nor any characters back. In this case if you have failed to enter Star Mode, you will see "ERROR" or "OK," which indicate that you are still in command mode.

Note that no address or phone number is required to start Star Mode. This is because Star Mode has no single destination. Once in Star Mode, the modem can exchange data with any other modem in the system that also is operating in Star Mode.

### *Exiting Star Mode*

To exit Star Mode, use three escape characters (+++) in a row:

```
+++
```

The three characters must have greater than one second of character times of blank space (no data) on *both* sides—that is, both before the three escape characters and after. You might diagram it this way:

```
<1 s>+++<1 s>
```

Your application actually will receive the exit instruction this way:

```
+++
OK<CR/LF>
```

The “OK” indicates that you are back in command mode. If nothing is returned, you are still in Star Mode.

### *Issuing AT Commands in Star Mode*

Except for connection commands (e.g., atdt, ath), you can issue any AT command from inside Star Mode. In addition, some AT commands are exclusive to Star Mode.

To issue a command, use &COMMAND as the send address in a Star Mode packet and place the desired AT command as ASCII data in the data area of the Star Mode packet. For example, the following shows how to use the `ats306?` command to display your modem name:

```
*&COMMAND*ATS306?
```

Where:

`*&COMMAND*` is the special string required to allow you to send standard AT commands to the Ricochet modem while in Star Mode. “&COMMAND” must be in uppercase letters.

`ats306?` is the actual AT command.

When echo is off (ate0), all carriage returns are suppressed except for the Star Mode packet terminator. The AT response also will be terminated to fit inside a single packet. If the packet is terminated, it will be truncated back to the last complete line of information. The format of the AT command response is:

```
*!MODEM*ATR<at command>\n<at command response>
```

For example:

```
*!MODEM*ATR ats306?
JANE

OK
*>
```

Where:

`*!MODEM*` indicates that the source of the response is the modem.

`ATR` is the name of the application that lets you query the modem with AT commands.

`Jane` is the response to the `ats306?` command.

Note that the AT command itself is echoed back in the packet.

### *Star Mode-Only AT commands*

It's often useful to determine neighboring modems so that your applications can automatically find others (for example, in the same room or building). This can be done with the Star Mode-exclusive AT~L Link Information commands. Use these commands to obtain information about each node the Ricochet modem has acquired. This information can then be used to talk to specific modems. Link Information commands act on one node at a time.

#### **\*&COMMAND\*AT~L#—How Many Links**

This command lets you determine the number of nodes the modem currently has acquired. This value is then used as the upper bound for the index in the other node commands. With seven modems, for example, the index entries will range from zero to six. Enter the following command:

```
*&COMMAND*at~l#
```

The following is a sample response:

```
*!MODEM*ATR at~l#
4
OK
```

The display indicates that four modems can be seen directly. These are modems that are available for communication and routing. Note that Ricochet Network radios are not available as Star Mode packet destinations and therefore are not counted in the display.

*NOTE: The index of a node is not fixed. It can change if the node reboots or changes information about itself, or if it is reacquired after being dropped.*

#### **\*&COMMAND\*AT~LN<number>—Name**

This command lets you display the handle for a node at a specified index number. For example, if you want to know the handle for the third modem (number 2 on the index), enter:

```
*&COMMAND*at~ln2
```

A sample response follows:

```
*!MODEM*ATR at~ln2
&ECB8B4BF2EA0C
OK
```

The modem response includes its handle, as indicated by the prefix E1.

This handle is valid until you exit the session or for as long as your modem “sees” the other modem. If the other modem is no longer seen and you have not exited, the handle may time out (not be used for a period of minutes) or the modem may have acquired more modems than it can keep entries for. In either case, the modem may discard the handle.

*NOTE: This command has been changed slightly for release 2.10. The parameter order was reversed for consistency.*



**\*&COMMAND\*AT~LA—Handles**

This command returns all of the handles that will fit in one Star Mode packet. They are sorted by received signal strength indicator (RSSI), from strongest to weakest. The list is delimited by the newline character. For example:

```
*&COMMAND*at~la
*!MODEM*ATR at~la
&EFAFA9821A1DE
&EA1A171C8B46C
&ECB8B4BF2EA0C
OK
```

**Star Mode-Specific S Registers****ATS319—Star Mode Configuration Register**

S Register 319 lets you configure Star Mode operation on your modem. It can be set to one of the following values (*default=0*):

Register Value	Meaning
0x0001	Display new/lost node information messages
0x0002	Display new best node information message
0x0004	Use checksums on all packets
0x0008	Enable ACK messages
0x0010	Force binary mode
0x0020	Disable Star Mode header on output from modem

**ASCII or Binary Mode**

Packets can be sent to the modem in either binary or ASCII mode, but all packets sent from the modem (including echoed packets) are in ASCII mode. To turn on Star Mode binary mode, enter:

```
ats319=10
```

For example:

```
*dicktracy~2*hi
```

There is *no* <cr>.

When using ASCII mode, each Star Mode packet transmitted from the modem through the serial port contains a leading carriage return. This character is not part of the checksum, if checksum is enabled. The extra carriage return facilitates error recovery for packet drivers on the host computer. The same can be done for packet drivers when delivering packets to the modem. Extra carriage returns should be discarded.

### Star Mode Header Options

To turn off the display of Star Mode headers, enter:

```
ats319=20
```

Turning off headers makes it easier to convert Star Mode for use in industrial applications that already have routing information in their protocols. Turning off headers may allow an application to send packets by simply prepending the Star Mode header to its protocol. The application can then more easily understand a response since there is no attached header. Also, there is a time savings if the receiving side doesn't have to spend time interpreting an unnecessary header.

### Checksum Options

When checksum mode is turned on, all Star Mode packets will have a checksum as the last four characters of the packet. These characters represent an ASCII 16-bit hex number. For example:

```
*!ois*How's the weather?A887 <cr>
```

If you are manually typing Star Mode packets, you will have to calculate the checksum using the following algorithm:

```
int calcChecksum(unsigned char * data,int len)
{
    int checksum=0;
    while (len--)
        checksum+=*data++;
    return checksum;
}
```

Note that the checksum is calculated over the whole packet, including stars, header and data but excluding the checksum characters and the “\r” character.

### ACK Options

When you turn on ACKs, you will see ACK messages for valid packets:

```
*!ACK*ACK_number
```

and NACK messages for invalid packets:

```
*!ERROR*ERR_012[] Failed to transmit packet
```

If checksums are turned on, then the number that appears in the ACK packet is the checksum. Note that the ACK is sent after the packet has left the modem, allowing you to also derive an estimate of packet delay. If checksums are not turned on, the number in the ACK packet is the number of successfully transmitted packets since the beginning of the Star Mode session.

### Information Response Options

You can turn on response messages that inform you when a new node has been added to or deleted from the active node queue and when the best node has changed. To turn on new node or lost node messages, use `ats319=1`. To turn on new best node messages, use `ats319=2`. To turn on all three command types, use `ats319=3`. The message formats are as follows:

```
*INFO*INF_001 New node [handle]
*INFO*INF_002 Lost node [handle]
*INFO*INF_003 New best node
```

### ATS316—Star Mode Path Life

The modem looks up the name of the specified target and remembers the network address of that target for the amount of time (in minutes) specified in this S Register. The range for this register is 1–255 (*default=3 min*).

### ATS317—Star Mode Path Cache Size

This is the maximum number of Star Mode paths stored by the modem. The range for this register is 1–6 (*default=6*).

### ATS324—Starmode Tx Q

This read-only register displays the number of Star Mode packets queued for transmission by this modem.

## Using Star Mode Commands

To send a packet to this node, you might enter:

```
*&ECB8B4BF2EA0C*METC/QUERY/METRICHAT?
```

Where:

`*&ECB8B4BF2EA0C*` is the destination handle ID

`METC` is the application ID

`/QUERY/METRICHAT?` is MetriChat for “Are you using MetriChat?”

The subsequent response may be an error display, indicating that the modem is not in Star Mode:

```
*&ECB8B4BF2EA0C*ERR_001 Not in Star Mode
```

The following is another kind of response:

```
*&ECB8B4BF2EA0C*METC/LINK/0000-3155/Nancy Wood
```

This response indicates that the modem is running MetriChat, its modem ID is 0000-3155 and the modem user is Nancy Wood. Since the response includes the modem ID, you will not have to use the handle in further packet exchanges. For example, to use the modem ID instead of the temporary handle, you could now send something similar to the following:

```
*0000-3155*METC/CHAT/Hi, Nancy! How's it going?
```

The following status message results:

```
*0000-3155*ERR_002 Remap handle &ELR-94CE24LL to name 0000-3155
```

The modem confirms that the handle matches the modem address used and discards the handle.

Notice that handles keep the identity of the destination modem secret. In a security-sensitive application, you may want to encrypt the data, including the node name, modem address, person name, etc.

## Star Mode Error Messages

The following are all the error messages that Star Mode may issue. They are returned to the modem in the following format:

```
*!ERROR*ERR_00X<message>
```

Possible error messages include:

```
ERR_001 Not in Star Mode!
ERR_002 [destination] Remap handle [destination]
ERR_003 [destination] Can't resolve
ERR_004 [destination] Too small
ERR_005 [destination] Bad count [%lu]
ERR_006 [destination] Header too big [%lu]
ERR_007 [destination] Body too big [%u]
ERR_008 [destination] Illegal name
ERR_009 [destination] Framing
ERR_010 [destination] Invalid checksum
ERR_011 [destination] Checksum didn't match
ERR_012 [destination] Failed to transmit packet
```

## Data Packet Conventions

In order to make Star Mode robust, you must assume there will be many modems in Star Mode that are not running your particular application. Therefore, a set of data packet conventions has been defined:

- To allow applications to easily identify packets generated by a different application. From here the application can choose to ignore the foreign packets, to issue some generic response, or to somehow forward the packet to another application. Metricom recommends issuing a “not my application” packet.
- To facilitate the creation of low-level drivers and daemons that will be able to route packets up to applications running in multi-session. An example might be running two or more wireless applications in Windows. Both applications could communicate via the same driver, which would handle all traffic to and from the wireless modem via the serial port.

The structure of the identifier is as follows (each letter represents a single byte):

mmmdata

where:

- mmm Three bytes of manufacturer ID code (ASCII). This is assigned by Metricom so that there are no accidental conflicts. Reserved codes include: ERR\_, INFO, ACK\_, METC and ATR. Please check with Metricom for other reserved codes.
- i One byte of application ID. This byte is at the discretion of the developer. You can use it to differentiate between applications, or packet types or whatever you wish.
- data The identifier is followed by any data you like, up to the maximum data length allowed (see S Register 313). Most applications should continue breaking out the packet data header by specifying fields such as packet function code, sequence number and any confirmation or checksum codes before free-form data.

We strongly encourage the use of this convention so that any applications you develop will be compatible with any Star Mode drivers and daemons that are developed, either currently or in the future. If you do not follow this convention, Metricom will be unable to support your development efforts.



# USER COMMAND SUMMARY

---

The following table describes the AT commands available to Ricochet subscribers:

AT Command	Description
ATA	Answer command
ATDT[ <i>number</i> ]	Dial a device or service
ATE0 ATE1	Disable echo in command state Enable echo in command state (default)
ATH	Hang up a connection
ATI[ <i>n</i> ]	Obtain product information; <i>n</i> =0, 1 or 4
ATO	Return to data state
ATQ0 ATQ1	Disable display of result codes (default) Enable display of result codes
ATS< <i>reg</i> >?	Display S Register value
ATS< <i>reg</i> >=< <i>val</i> >	Set S Register to a value
ATS?!	Display Ricochet-Only S Registers
ATV0 ATV1	Select verbose result codes Select numeric result codes (default)
ATW0 ATW1, ATW2	Turn off extended result codes (default) Select extended result code
ATX[ <i>n</i> ]	Control set of result codes that are returned: <i>n</i> =0, 1, 2, 3 or 4 (default)
ATZ ATZ9	Restore configuration to power-on state Hard reset
ATZ8	Set sleep mode (not SE)
AT&C0 AT&C1	DCD always on (default) DCD on when the modem is connected to another modem
AT&D[ <i>n</i> ]	Control DTR; <i>n</i> =0 (default), 1, 2 or 3
AT&F	Set configuration to factory default
AT&I	Display industrial mode statistics

AT Command	Description
AT&K0 AT&K2/AT&K4 AT&K3	Turn off hardware handshaking (default) XON/XOFF Turn on hardware handshaking
AT&N0 AT&N1	Don't acquire other portable modems (default) Acquire other portable modems
AT&V	Display the values of the lower 32 S Registers
AT&W	Save the current configuration and S Registers to non-volatile memory
AT-B[n]	Configure the modem as bridge $n=0$ (default), 1, 3, 5, 7
A/	Repeat last command



# USER S REGISTER SUMMARY

---

The following table summarizes modem S Register settings:

S Register	Description	Factory Default
<b>AT-Compatible S Registers</b>		
0	Answer mode (0 or 1)	0
2	Escape sequence character	43 (+)
3	Command line terminator	13 (cr)
4	Line feed character	10 (lf)
5	Backspace character	8 (bs)
7	Connect attempt timeout	60 seconds
<b>Ricochet-Only S Registers</b>		
300	Date the radio or modem was created, its serial number, its part number and its software version level (read only)	
301	Serial # (read only)	<unique serial number>
304	Baud rate—(0 for autobaud)	0
305	Modem number (read only)	###-###
306	Unique name	<unique name>
310	Expected links	16
311	Best links (read only)	
313	Max data size (read only)	1183 bytes
314	ATA timeout	10 seconds
316	Path life	3 minutes
317	Path cache size	6
318	Net timeout	0 milliseconds (never)
319	Star Mode configuration	0
320	Active baud rate (read only)	

S Register	Description	Factory Default
321	Ring delay	1
322	Connect password	no password
323	User inactivity	0 seconds (no timeout)
324	Starmode Tx Q	
325	Battery voltage (read only)	volts
326	System inactivity	10 minutes
327	Sleep mode	0
330	Service password 1	no password
331	Service password 2	no password
340	Connection mode	12 (Light/PPP)
341	Encrypt seed	no password
342	Encrypt key length	32
343	Key renegotiation	100
360	Icon status	
361	Serial status	
380	RF download	0
390	Mfg Pn	0
391	R3 date	0
392	R5 date	0
393	Mfg Pn Rev	32
400	Boots	
800	Modem control	ATX4&C1&D2
802	Bridge config/Auto-start	0
803	Phone number limit	60
804	Dial string	0

# CABLE PINOUTS

## PC Serial Modem Cable Pinouts

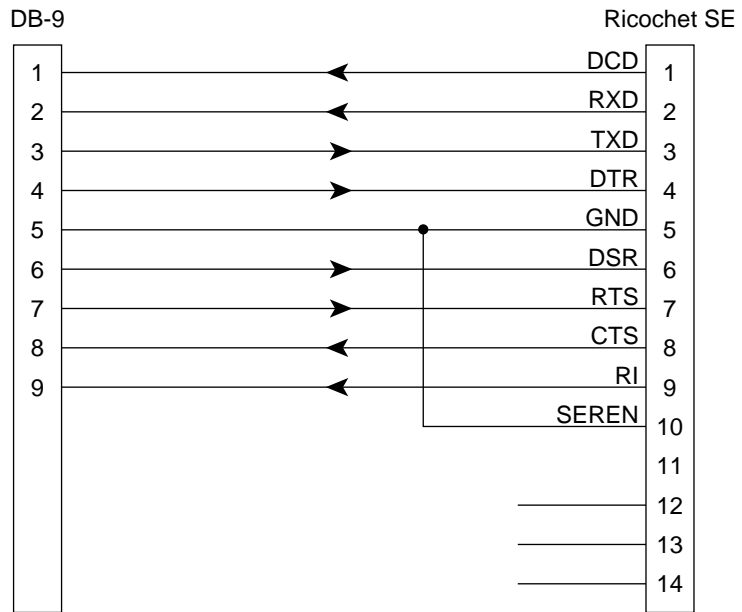
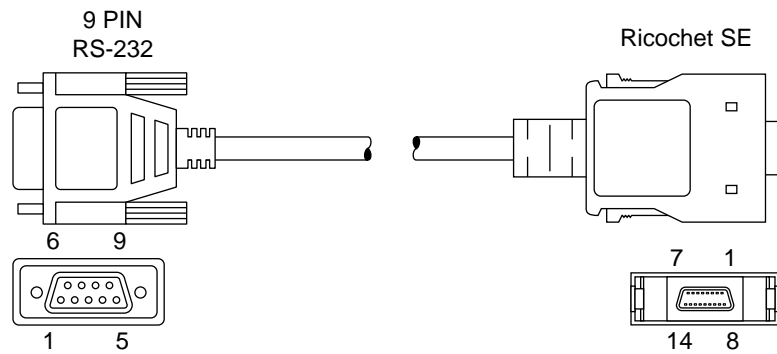


Figure 10. Ricochet SE PC Modem Cable

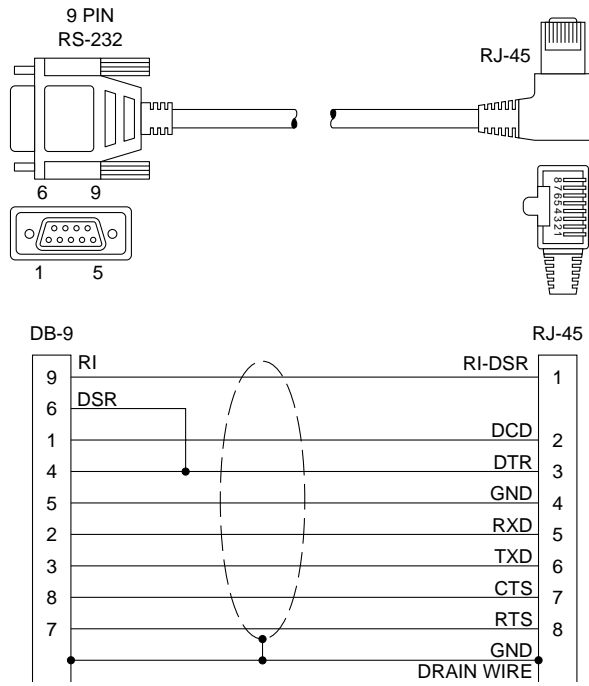


Figure 11. Phase II PC Modem Cable

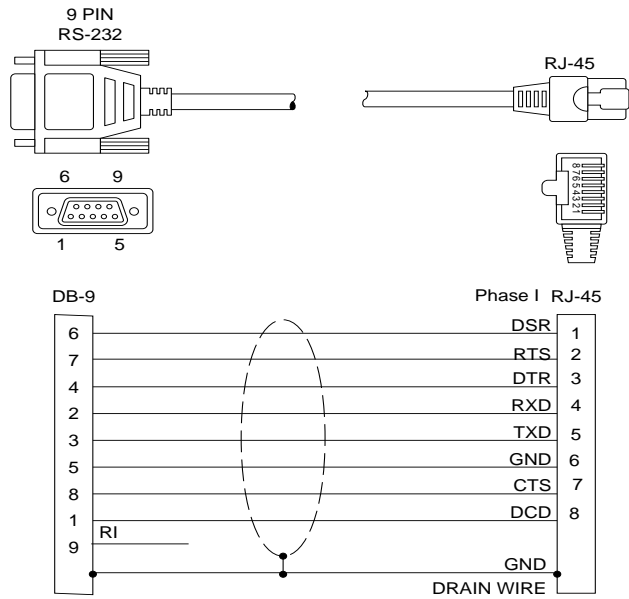


Figure 12. Phase I PC Modem Cable

## Macintosh Serial Modem Cable Pinouts

0

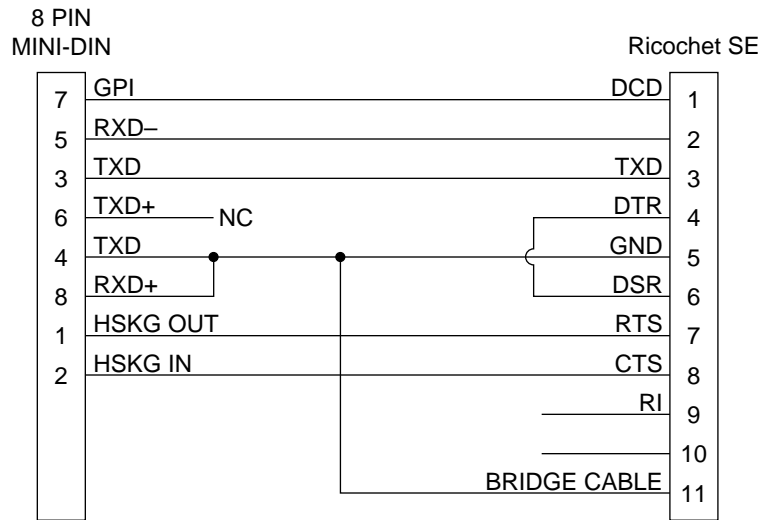
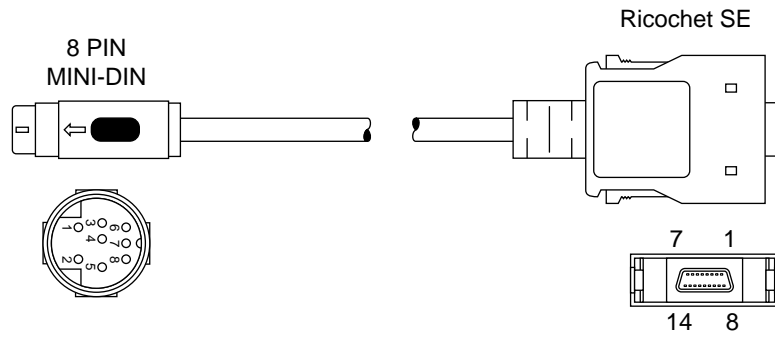


Figure 13. Ricochet SE Macintosh Modem Cable

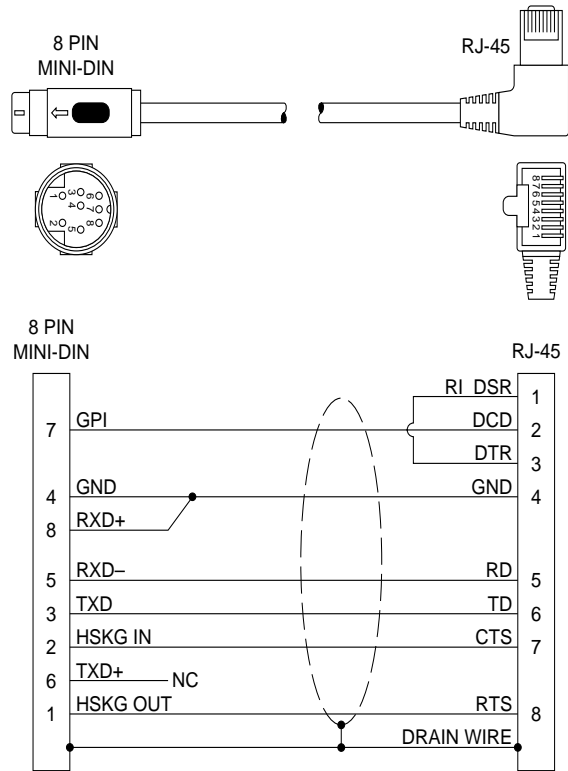


Figure 14. Phase II Macintosh Modem Cable

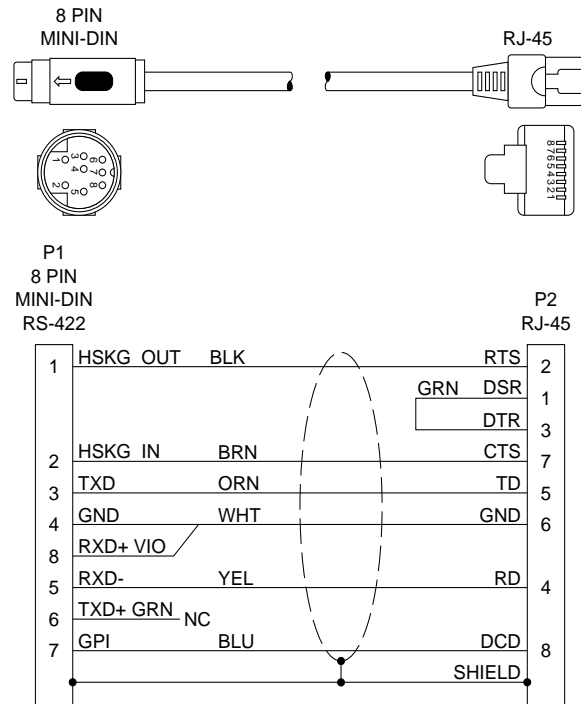


Figure 15. Phase I Macintosh Modem Cable





# Glossary

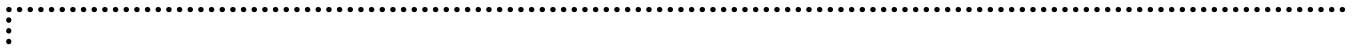
---

ACK	A packet sent in response to another packet; short for acknowledgment.
Acquire	See <i>acquisition</i> .
Acquisition	The process that a modem uses to discover its neighbors and begin communicating with them.
Autobaud	Rather than setting a modem for a fixed transmission speed, a modem configured for autobaud operation will instead negotiate a rate with the device at the other end of a connection.
bps	Bits per second. A measurement of the number of bits transmitted per second.
Break Signal	A command that interrupts normal execution to allow for manual intervention.
Carrier Signal	A continuous frequency sent out by the modem, capable of being altered to carry data. This is the signal a modem looks for before it begins to send data.
Clear to Send (CTS)	A signal that indicates whether the modem is ready to accept data from a terminal or computer for transmission.
Command Line	A string of commands entered on a single line, usually beginning with AT and ending with <cr>. Commands entered on the command line can be input in any order.
Command State	The mode of operation in which the modem responds to commands instead of exchanging data with another modem.
Communication Software	The computer program or application that allows your computer to communicate with the modem.

Data Packets	Packets that carry useful data and are not necessarily used for acknowledgment of other packets.
Data Carrier Detect (DCD)	A signal that indicates whether the modem could or could not be receiving transmitted data.
Data Set Ready (DSR)	A signal that indicates whether the modem is connected to a communication channel and is ready to exchange control characters to begin data transmission.
Data Terminal Equipment (DTE)	Your computer: the equipment needed to support the transmission of data from the receiving device to the originating device.
Data Terminal Ready (DTR)	A signal that says the DTE is there.
Echo	A display on your computer screen of commands you have typed and system responses.
Escape Sequence (+++)	Characters that cause the modem to interrupt online processing and exit to the command state while remaining connected to the remote system. The escape sequence indicates that the subsequent characters are to be interpreted as control characters rather than as data.
Gateway	A box that receives one data protocol and converts it into another protocol.
Handshaking	The exchange of control characters between an input/output (I/O) device and an I/O interface. The characters indicate that the device is ready to receive data, that the data has been sent and that the data has been accepted. In hardware handshaking, the Clear To Send (CTS) and Request To Send (RTS) lines status are observed. They control the flow of data between devices, ensuring that no resources are overused so that no overruns occur.
Link Packets	Packets used by communicating Ricochet devices to exchange information among themselves. Link packets contain information about connectivity, time, hardware configuration, location, etc.
MAC Address	The unique six-byte address that every radio must have.
Parameter	A communications setting that determines the characteristic or behavior of a particular feature.
Parity	A form of error checking that involves a checksum performed on each transmitted character.
Request to Send (RTS)	When used for flow control between a DTE and the modem, this signal indicates to the modem that the DTE is ready to accept serial data.
Result Code	A message from the modem indicating the result of a command or progress of a call.

---

<b>Routing</b>	The action required to get a packet from one place to another.
<b>S Register</b>	A memory location where the modem stores parameters, settings and other operating information.
<b>Serial Transmission</b>	A method of transmission in which each bit of information is sent sequentially, one bit at a time, over a single line.
<b>Synchronous Communication</b>	A communications method in which bits are transmitted and received at a fixed rate, with the transmitter and receiver synchronized.
<b>Syntax</b>	The formula that defines command format and enables the modem to interpret commands correctly.
<b>Terminal Emulation Program</b>	Communications software that allows characters typed on a computer keyboard to be sent directly to another device. Sometimes called “dumb” terminal emulation.



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