RIM 902M Radio Modem

Integrator Guide

Version 2.5

RIM 902M OEM Radio Modem Integrator Guide
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FCC compliance statement

FCC Class B Part 15

This device complies with Part 15 of FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Warning! Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user’s authority to operate this equipment.

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. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the manufacture’s instructions, may cause harmful interference to radio communications.

There is no guarantee, however, that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

The Integrator of the RIM 902M Radio Modem is solely responsible for obtaining all necessary government approvals, including but not limited to, Electromagnetic Compatibility (EMC) compliance and applicable radio frequency radiation exposure evaluations, such as Specific Absorption Rate (SAR), Environmental Assessment (EA), and Maximum Permissible Exposure (MPE) testing, for all RF radiating devices from the governing bodies in the nations in which the product and / or Resultant Product will be marketed or sold.

The Integrator of the RIM 902M Radio Modem understands and agrees that any grant of authorization to RIM from the Federal Communications Commission (FCC), or any other foreign government body / commission, extends only to technical specifications and configurations expressly verified by RIM as in compliance with FCC or other government body / commission's EMC and applicable RF radiation exposure regulations. Any engineering or other changes to RIM products delivered by RIM to the Integrator, which are not consistent with the design specifications approved by RIM and the FCC or other government body / commission, shall be the sole responsibility of the Integrator, and RIM expressly does not warrant that such changes are permissive or otherwise acceptable under FCC or other government body / commission's regulations. The Integrator understands and agrees that such engineering or other changes may cause the product and / or Resultant Product's non-compliance with FCC or other government body / commission's EMC and / or RF radiation exposure regulations and the Integrator hereby assumes all regulatory and legal responsibility for same.

The FCC approval process requires testing to be completed and a report submitted to the FCC before the Resultant Product may be granted FCC certification. This can be a lengthy process, taking four months or more for completion. This certification must be received prior to the sale in the U.S. of any Resultant Product containing the RIM 902M Radio Modem by the Integrator. More information can be found in this guide. Please contact the FCC or RIM for further details.

Industry Canada certification

This device complies with Industry Canada RSS 119, under certification number 2503195550A.

IC Class B compliance

This device complies with the Class B limits for radio noise emissions as set out in the interference-causing equipment standard entitled “Digital Apparatus,” ICES-003 of Industry Canada.

Contents

1 Introduction

The RIM 902M Radio Modem set a new standard for radio modem performance in key areas, such as receiver sensitivity, output efficiency, noise immunity, and power consumption. Its small size and weight make it suitable for virtually any wireless data application, including handheld devices and mobile terminals.

The RIM 902M Radio Modem operates on Mobitex wide-area wireless data networks in the 900 MHz range, such as Cingular Interactive and the Rogers AT&T Mobitex networks.

The RIM 902M Radio Modem is designed to integrate easily into a computing device. Potential applications include:

- Laptop computers
- Point-of-sale devices
- Ruggedized terminals
- Handheld computers
- Parking meters
- Dispatching
- Vehicle tracking
- Monitoring and telemetry
- Vending machines
- Utility meters
- Billboards
- Security alarm panels

Radio performance

The RIM 902M Radio Modem offers high performance on Mobitex networks.

Receiver sensitivity

The RIM 902M Radio Modem has a receiver sensitivity of –116 dBm at 0.01 bit error rate (BER). This means that the radio can interpret received data from a very weak signal (0.0025 picowatt) with a 1% bit error rate. 1% is an industry standard error rate used to define sensitivity, and does not indicate that 1% of the data passed by the radio to the application is corrupted. The sophisticated over-the-air Mobitex protocol corrects these errors before data is passed to the application, ensuring error-free communication. This capability is already built into the radio's firmware, and does not require any additional software development.

Receiver sensitivity is a measure of how well the radio modem can receive and decode data from a network base station. This figure is important when a device is used in areas where signal strength is weak, such as inside buildings and in locations that are not close to a base station. A radio modem with good receiver sensitivity can be used in more places than a radio modem with poor sensitivity.

Noise immunity

RIM radio modems are not desensitized by the electromagnetic interference (EMI) or "noise" that is generated by the electronics of the terminal into which it is integrated. As a result, no special shielding is required between the radio and your device.

Noise immunity offers several key benefits:

- easier integration
- longer battery life
- increased reliability
- improved RF performance

- more coverage from each base station
- no need for special RF shielding

Powerful and efficient transmitter

When necessary, the RIM 902M Radio Modem can supply a full 2.0 watts to the antenna. The radio modem quickly decreases the output power, however, when it is close to a base station——to as little as 0.062 watts – because a stronger signal is needed only when far from a base station. By transmitting a strong signal only when necessary, the radio modem conserves battery power and ensures a balanced link.

RIM radio modems provide reliable, efficient transmission across the entire operating voltage range of 4.1 to 4.75 volts. Batteries can be used even when they are almost depleted, which maximizes the radio coverage area throughout the life of the battery.

Low power requirements

If you are planning to integrate RIM 902M Radio Modem into a handheld or portable device, battery life is a critical issue because customers insist on long-lasting devices without heavy battery packs. The RIM 902M Radio Modem provides superior power consumption to ensure efficiency and to maximize battery life.

- Transmitting data: 1.7 amps or less (at 4.5 V), depending on output power.

  The transmitter is on for a pulse of between 32 ms and 1 second per packet, depending on the amount of data transmitted. The maximum packet size for a Mobitex device is 512 bytes.

- Receiving data: 54 mA (at 4.5 V)

  The radio turns on its receiver for a 150 ms "window" once every 10 seconds. The base station only attempts to communicate with the radio during this window. To minimize latency during rapid 2-way communication, the receiver is also turned on and kept on for 10 seconds after any communication (transmit or receive) with the network.

- Standby power: less than 0.2 mA at 4.5V

  Standby power is very low and occurs when no radio activity has taken place for at least 10 seconds. The radio and base station are closely synchronized to ensure that a communication attempt is not missed when the radio is in standby mode.

Battery life is not a concern for some applications, such as in-vehicle applications that draw power from the vehicle battery. In this case, it is possible to put the radio in an express operating mode, in which the receiver is on all the time. This mode results in higher power consumption, but packet receive latency is minimized.

Small size

Using a single-board design, the RIM 902M Radio Modem is very thin, and smaller than a business card. It measures 1.65 by 2.66 inches (42.0 by 67.5 mm). This small size allows the radio modem to meet tight space requirements within most applications. Its single-board design is more reliable than multi-board designs, particularly in high-vibration environments (such as vehicles) or in devices that can be dropped (such as handheld computers).

Mobitex network technology

Mobitex wireless network technology, developed by Eritel in 1984 for Swedish Telecom, has become an international data communication standard. It is a secure, reliable, wireless packet-switching network specifically designed for wide-area wireless data communications.

Mobitex networks are deployed around the world. The technology is presently available in the following countries:

Australia	Germany	Singapore
Austria	Indonesia	Sweden
Belgium	Italy	Turkey
Canada	Korea	United Kingdom
Chile	Netherlands	United States
Finland	Norway	Venezuela
France	Poland	

Mobitex networks in the United States, Canada, Korea, Chile, and Venezuela operate in the 900 MHz range, and therefore are directly compatible with the RIM 902M Radio Modem. Currently, Mobitex networks in other countries operate at other frequencies, such as 400 MHz.

Mobitex provides reliable, 2-way digital data transmission. The network provides error detection and correction to ensure the integrity of the data being sent and received, and includes transmission acknowledgment.

The networks have a hierarchical structure that enables messages to be routed from sender to receiver along the most direct path possible. Each radio cell is served by an intelligent base station. Because intelligence is distributed throughout the network, data is only forwarded to the lowest network node that is common to the sender and the receiver. As a result, one base station is able to handle all traffic in its coverage area.

The network constantly monitors the location of mobile users. As a mobile device moves from one area of coverage to another, base stations track its signals, sending updated mobile location and status information to the network. If the network is unavailable at any point in transmission, the message is held until network service is restored. If the mobile receiver moves outside the coverage area, the base station stores the data until coverage is re-established, then forwards it to the mobile device. This process prevents data loss, and increases the reliability of transmission.

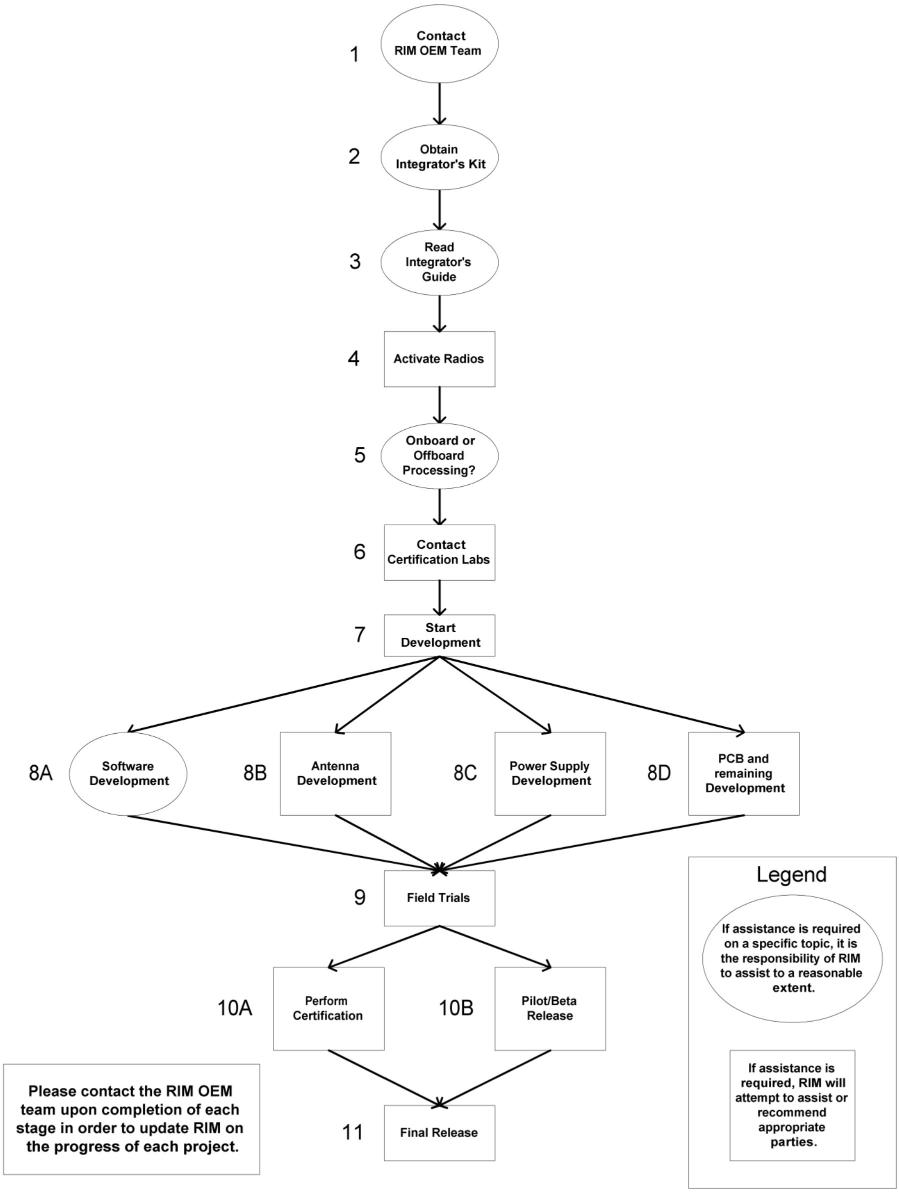
Mobitex is optimized for data communication. It uses a packet-switching technique to provide the greatest flexibility in data transmission. By contrast, conventional cellular phone systems use a circuit-switched network, in which a physical connection is created between the sending and receiving nodes. This connection must be maintained throughout the duration of the transmission. With circuit-switched systems, the setup time for establishing a connection involves significant overhead and airtime cost, especially when only a small amount of data needs to be transferred.

Network data packets include information about the origin, destination, size, type, and sequence of data to be sent. This information enables packets to be transmitted individually, in any order, as traffic permits. Internal to the network, individual packets can travel along different routes, in any order, without interfering with other packets sent over the same frequency by different users. At the receiving end, all packets are accounted for, and reassembled into the original message.

Setup time is eliminated and network connection is instantaneous. Packet-switching uses channel capacity efficiently, typically allowing 10 to 50 times more users over a radio channel than a circuit-switched network.

Integration steps

The following flowchart illustrates the integration process.



1. Contact the RIM OEM team

Email OEMinquiry@rim.net or call (519) 888-7465 x5200 to obtain more information about RIM Radio Modem products and whether they are suitable for your application.

2. Obtain Integrator's Kit

You can request the Integrator’s Kit from Research In Motion. This kit includes the radio modem, a mechanical sample of the radio, an interface and test board, a Software Developer's Kit for onboard application development, AC to DC power supply, required cables, magnetic mount antenna, and documentation.

3. Read the *Integrator's Guide*

Read the *Integrator's Guide* first to ensure you follow proper procedures to prevent unnecessary delays and damage to equipment. This guide explains topics such as mounting requirements, battery power characteristics, interfaces to the RIM radio modem, and antenna selection and placement.

4. Activate the Radio

Contact the appropriate network provider to activate the radio modem. For network contact information, visit `http://www.rim.net/oem` or contact RIM at oemsupport@rim.net.

5. Choose Onboard or Offboard Processing

Determine if your application will use the onboard 386 processor of the radio modem, or a processor located in an external, attached computing device.

If you will use the onboard processor, read the *SDK Developer Guide* to write a software application to be stored on the radio.

If you will not use the onboard processor, read the *Radio Access Protocol (RAP) Programmer's Guide* to learn how to communicate between the offboard processor and the radio.

6. Contact Certification Labs

Learn about obtaining FCC and / or Industry Canada certification. Radio frequency (RF) emitting products cannot be sold in the United States or Canada until you have the proper government approvals. Understanding what you are permitted to do before beginning your design can save redesign costs later on.

For more information on testing, visit `http://www.rim.net/oem/` or contact the RIM at oemsupport@rim.net.

7. Start Development

You should plan your project carefully before starting development. You must address several important considerations when planning your design. To speed up the development process, you can often perform several procedures in parallel.

Contact RIM at oemsupport@rim.net for further details.

8A. Develop Software

Start developing your software application. If you are using the onboard processor, RIM will help if you encounter any problems with the onboard application. If you are not using the onboard processor, RIM will help if you encounter any problems with the communication between the offboard and onboard processor using the Radio Access Protocol (RAP).

8B. Develop an Antenna

Several antennas have been certified for use with the RIM radio modem. Refer to the *Integrator's Guide* for details. If these antennas do not meet your needs, start developing an antenna for use with the final product. Please refer to the *Integrator's Guide* for guidelines on antenna development. In addition, contact RIM for general assistance and for recommendations of antenna companies that can help further to a greater extent.

8C. Develop a Power Supply

Start developing the power supply for the product. Refer to the *Integrator's Guide* for guidelines on the strict power requirements of the RIM radio modem. Contact RIM at oemsupport@rim.net for further details on power requirements, guidelines for power supply development, and recommendations of power supply companies that can assist to a greater extent.

8D. Complete PCB and Remaining Development

Start developing the housing and Printed Circuit Board (PCB) for the product. Refer to the *Integrator's Guide* for guidelines on radio and antenna placement.

9. Conduct Field Trials

Start product field trials to ensure performance and reliability.

10A. Perform Certification

Choose a testing lab to perform FCC or Industry Canada certification, and any applicable network certification. Before sending your product for testing, contact RIM to ensure that the solution is set up properly for testing. For more information, visit `http://www.rim.net/oem/`.

10B. Pilot/Beta Release

Contact RIM prior to beta release of the product, especially if the product has not been certified yet. There are very specific guidelines that must be followed to ensure legality of the release prior to certification.

11. Final Release

Congratulations on having completed the development process! Contact RIM if you encounter any obstacles related to the RIM radio modem. In addition, please provide regular updates to RIM on the progress of the release.

2
Getting started

RIM is committed to facilitating the integration of the RIM 902M Radio Modem. RIM provides the necessary resources to evaluate the feasibility of implementing a wireless communication solution, and works closely with partners to develop an application in the shortest time possible.

The Integrator's Kit includes several tools to help streamline the evaluation and integration process. Using the kit, you can interface the radio modem to your computing device quickly.

Note	The radio modem that is part of the Integrator's Kit has not been activated on the Mobitex network. Contact your Mobitex network provider to activate the radio modem.

Working with RIM

RIM has an experienced team to help you with design and implementation. If you need help getting started, or if you have any questions about the radio technology or its integration into your platform, contact the engineering development team:

Phone: +1 (519) 888-7465
Fax: +1 (519) 883-4940
Email: oemsupport@rim.net
Web Site: `http://www.rim.net/oem`

Test board overview

The RIM test board provides a standard RS-232 serial interface between a computer and the radio modem. The test board helps you interface the RIM 902M Radio Modem to a standard computer using a COM port, or to a terminal device using a RS-232 serial port. The test board also provides access points to the radio's communication port, which enables you to monitor activity with a logic probe, multimeter, or oscilloscope.

The test board includes the following components and functionality.

RS-232 interface

The RS-232 interface on the test board allows you to produce an output from the radio that is easily interpreted by a computer.

The serial (COM) port on a computer and most terminal devices operates at RS-232 signal levels, which are typically ±12V. This high voltage would damage the RIM 902M Radio Modem, which is typically integrated into a device that operates an asynchronous serial port at 3.0V.

Test points

The test board provides debugging facilities to help you test your application. It provides direct access to each of the 22 pins on the radio interface cable, which enables connectivity to analytical equipment, such as a logic probe, multimeter, or oscilloscope, and real-time indication of data flow.

On/off switch

When the switch is on, the radio turns on whenever power is applied to the test board. When the switch is off, the radio shuts down.

Power supply

The RIM 902M Radio Modem requires a clean, high-current power source. RIM uses a standard plug-pack to provide the current necessary to operate the radio. The voltage is converted into the necessary levels by the power supply section on the test board.

LED indicators

The test board includes several LED indicators designed to indicate the flow of data to and from the host (in real time), the radio power status, power to the test board, and more.

Connecting the test board

You must connect the RIM 902M Radio Modem to an antenna and to a computer, or some other device with a RS-232 serial interface. Use the test board and cables supplied with your Integrator's Kit.

1. Connect the test board to the modem

Connect the flat interface cable between the test board and the radio. When you insert the cable, ensure that the side with the bare pins is in direct contact with the pin side of the connector. Do not force the cable into the connector; instead, pull the tabs on either side of the connector, slide the cable in, and push the tabs back in.

The flat interface cable delivers clean, regulated power to the radio modem. The cable also carries data and control and status signals, such as `TURNON`, between the test board and the radio modem.

2. Connect the test board to the computer

Connect the male end of the straight-through DB-9 serial cable to the test board. Connect the female end of the cable to the computer's COM port.

3. Connect the power adapter

Plug the 5VDC, 2.4A, center-pin-positive power adapter into the wall AC outlet. Connect the other end to the power jack of the test board.

4. Connect the antenna cable

The Integrator's Kit includes a high-performance, 6dB-gain magnetic mount antenna, which is terminated with a screw-on SMA plug. The radio modem includes a snap-on MMCX jack.

Connect the antenna cable between the antenna's SMA plug and the radio MMCX jack.

The antenna provides optimum RF performance when placed on a broad metal surface, such as the roof of a car. When used inside a building, performance is improved if the antenna is located near a window, with few obstacles between the antenna and the window. You should set up the antenna vertically for best performance.

5. Turn on the system

The power switch on the test board is connected to the TURNON line of the RIM 902M Radio Modem. To determine whether the radio is on, look at the LED marked ON. It is lit when the radio is on.

Note	Your network operator must activate your radio modem and establish an airtime agreement so that you can use the Mobitex network. If you have not already arranged for activation of your radio, contact your network operator.

Using the MENU tool

The RIM 902M Radio Modem contains a diagnostic utility called MENU. This utility enables you to set the current network, send test messages to the radio modem, and monitor radio and network status.

The MENU utility is embedded in the radio modem firmware.

Note If you load an application created with the Software Developer's Kit (SDK) onto the radio modem, the MENU utility does not function when the serial port is open. To access MENU again, you must remove the application. Refer to the *SDK Developer Guide* for information about creating, loading and removing applications.

Setting up the MENU tool

You must connect the radio modem to a computer running a terminal program, such as Windows HyperTerminal.

The MENU utility has a full-screen, text-based user interface and uses the ANSI cursor command set. HyperTerminal supports ANSI codes by default. If you are using a different terminal program that does not provide ANSI cursor control, the MENU utility changes to a line-by-line interface. The commands are the same for both the line-by-line and the full-screen interfaces.

Setting up the terminal program

Select the COM port to which you connected the radio modem.

Specify the following port settings:

- Bits per second: **9600 bps**
- Data bits: **8**
- Parity: **None**
- Stop bits: **1**

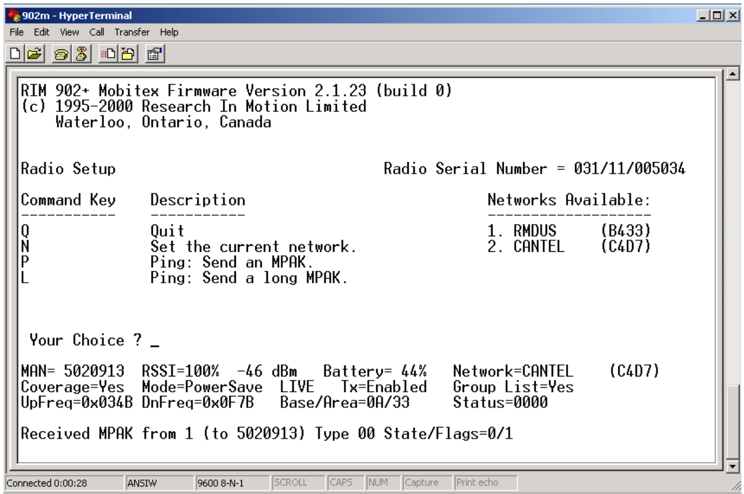
After you connect your terminal program to the radio modem, you might see occasional bursts of characters on the terminal screen. This is normal.

Starting the MENU tool

Type **menu** (in lower case) and press ENTER.

The word “menu” does not necessarily appear on the screen when you type it.

When the utility starts, a full screen of information appears, as shown below:



If nothing happens, retype **menu** until the radio modem responds. If you continue to have problems, verify that the radio is turned on and connected to the computer, and that all cables are connected securely. Contact RIM for assistance if you are unable to continue at this point.

The MENU screen displays the software version, the radio modem serial number, a list of available wireless networks, a list of setup commands, and status indicators.

To use a setup command, you type the letter for the command at the **?** prompt.

The following sections describe each status indicator.

MAN The MAN field indicates the unique Mobitex Access Number (MAN) of the radio modem, which is used for addressing packets. The Menu screen also shows the **Radio Serial Number** of the radio modem.

RSSI The Received Signal Strength Indicator (RSSI) is a measure of network coverage. The higher the number, the stronger the coverage. The RSSI is given both as a percentage and in dBm (decibel milliwatts). Note that “RSSI= 0% 0 dBm” does not necessarily represent the complete absence of a signal; in many cases, the radio is capable of communicating with the network at signal strengths of 0 dBm or less. The **Coverage** field shows whether the radio modem is activated and within wireless network coverage. The RSSI is updated every ten seconds, or when you press **D**.

Battery The Battery field shows the level of supplied voltage. The battery level is updated every thirty seconds, or when you press **D**.

Network The Network field shows what network you are currently using; for example, RMDUS (Cingular Interactive) or CANTEL (Rogers AT&T).

Coverage The Coverage field shows whether the radio modem has contact with the wireless network.

Mode The Mode field shows whether the radio is in Powersave mode or Express mode. The default operating mode is Powersave, which reduces power consumption of the radio but introduces latency when receiving packets from the network. Applications can change this mode. See “Reducing power consumption” on page 45 for more information.

Tx The Tx field indicates whether the radio’s transmitter is enabled or disabled. The transmitter can be enabled or disabled by your application, and is normally enabled.

The Mobitex base station may also instruct a radio to shut down (also referred to as DIE) if it is an illegal device, not registered, or causing disruption to the Mobitex network. If your device is in a DIE state, contact your network operator. The word `Live` on the status line indicates that the radio is not in a DIE state.

Group List The Group List field shows the Group List that the radio modem received when it is powered up and registers with the network base station. Normally, you would see `Group List=Yes`, which indicates that the radio has successfully signed onto a base station. If you see `Group List=Born`, then either your device is out of coverage, or it has not been activated by your network operator. Note that it can take 30 seconds for a radio to display `Group List=OK`.

UpFreq The UpFreq field shows the channel, in hexadecimal format, that you are using to transmit data.

If you are interested in obtaining the exact current transmit frequency, divide UpFreq by 80 and add to 890. This gives a value in MHz. Add 39 MHz to obtain the receive channel. For example, if the display reads `UpFreq=02FF DnFreq=0F2F` then convert hexadecimal 02FF to decimal 767, divide by 80 and add to 890, and obtain 899.5875 MHz, which is the transmission channel. Add 39 MHz (or repeat the calculation using DnFreq) to determine that the receive channel at 938.5875 MHz.

DnFreq The DnFreq field shows the channel, in hexadecimal format, that you are using to receive data.

Base/Area The Base / Area field indicates which base station you are using. Every base station in the network is assigned a unique Base / Area combination. Base stations in the same geographic area often share an Area address. Contact your network operator if you want to know the location of network base stations.

Status The Status field indicates the current state of the radio. Other documentation may also refer to the Status value as the radio's internal fault bits. The following table shows the interpretation of the Status bits. If the Status value displayed on your screen does not correspond to any of the values below, then determine which values add together in hexadecimal to give the Status value that you see. For example, status value B403 would simultaneously describe states A000, 1000, 0400, 0001, and 0002, as described below.

Note	Please note: if status bits are set, it does not necessarily indicate that there is a fault with the radio. These bits are useful only for troubleshooting a known problem, and should not be read or interpreted by any application. For example, it is possible for the status bits to read 0040 yet the radio is able to transmit.

Status	Description
0000	The radio modem status is normal. There are no warnings.
0001	The radio modem has been out of network coverage for a long time. No adequate base station was found. Possible causes include lack of network coverage, wrong network selected, or the battery level is too low.
0002	This is a new radio modem being used for the first time. No action is necessary.
0008	The radio modem has exhausted its internal memory. This should not happen under ordinary use. To resolve this problem, turn off the radio modem and then turn it on again.
0020	The network has issued a `DIE` command to the radio modem, perhaps because it is not registered on the network. No data can be sent to the network until a `LIVE` command is issued by the network. Contact the network operator for help.
0040	The modem's transmitter has been disabled by your software, using either the MASC `F M0` or RAP `Turn Transmitter Off` command. The transmitter can be turned back on with the MASC `F M1` or RAP `Turn Transmitter On` command, or by resetting the radio.
0080	The radio modem has not yet received a group list from the network. If this bit remains set after the modem is in network coverage for several minutes, your radio modem is probably not activated. Contact the network operator to activate your device.

Status	Description
0100	Another device might be using the same MAN as your device on the same base station. This should not happen under ordinary use. It may cause duplicate, dropped, or mixed-up packets. Contact the network operator to determine whether two units have the same MAN.
0800	The radio modem might be having a problem remembering its last base station. If the problem persists, return the unit for repair.
1000	The radio modem has received an unknown interruption and might be having problems receiving packets. If the problem persists, return the unit for repair.
2000:	The radio modem has received an unknown interruption. No action is necessary.
4000	The radio modem has been damaged and cannot be used until this problem is corrected. Return the unit for repair.

Changing to a different network

RIM radio modems can be used on different Mobitex networks operating on different channels. RIM can program up to 16 network channel lists into each radio. If the network shown is not the correct one, you can choose another from the list of networks available.

1 Type **N**.

The MENU utility displays a prompt to select the network.

2 Type the number that corresponds to a network displayed under the Networks Available field.

3 Press **ENTER**.

The radio modem changes to the selected network. If you do not type a number, or if you erase the number you have typed, no change occurs.

Press **ESC** to cancel the network setup command.

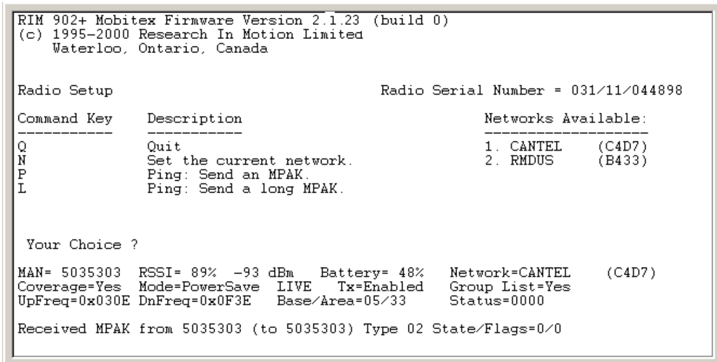
Testing network connectivity

You can determine whether your radio modem is working on the network by sending a test data packet to the radio modem.

Type **P**.

The **P** (“ping”) command sends a data packet to the radio modem using the wireless network base station.

The MENU utility displays a message indicating that the packet was sent. A few seconds later, the MENU utility should indicate that the packet was received, confirming that your radio modem is operational and active on the network.



```
RIM 902+ Mobitex Firmware Version 2.1.23  (build 0)
(c) 1995-2000 Research In Motion Limited
    Waterloo, Ontario, Canada


Radio Setup                                 Radio Serial Number = 031/11/044898

Command Key    Description                              Networks Available:
-----------    -----------                              -------------------
Q              Quit                                     1. CANTEL    (C4D7)
N              Set the current network.                 2. RMDUS     (B433)
P              Ping: Send an MPAK.
L              Ping: Send a long MPAK.



 Your Choice ?

MAN= 5035303  RSSI= 89%  -93 dBm   Battery= 48%   Network=CANTEL    (C4D7)
Coverage=Yes  Mode=PowerSave  LIVE   Tx=Enabled   Group List=Yes
UpFreq=0x030E DnFreq=0x0F3E   Base/Area=05/33     Status=0000

Received MPAK from 5035303 (to 5035303) Type 02 State/Flags=0/0
```

If you do not receive a confirmation message that the packet was received, perform the following tasks to determine why you are unable to communicate with the network:

- Check with the network operator to ensure that your device is activated on the network. If the radio has not been activated, then the network will not send the MPAK back to the radio. The MENU tool always shows an `RSSI` value, even if your modem is not activated.
- Ensure that you are in network coverage. You can determine whether you are in coverage by looking at `Coverage` on the status lines. If it shows `Coverage=NO`, then you are not in an area that is covered by your Mobitex network.

- Ensure that the antenna is connected properly and is positioned vertically. Signal quality can vary significantly in buildings. Try moving the antenna to a new location, perhaps near a window, to see if you can improve the signal.

Exiting the utility

When you have finished using the utility, press **Q** to quit.

This step is important because it enables the radio modem to resume accepting commands from other software. The screen clears and a message appears indicating that the radio is reset. You can safely disconnect the radio and close your terminal program after you receive this message.

3
Mechanical integration

This chapter explains how to determine the position of the radio modem within an application, including the following topics:

- environmental properties
- physical properties
- mounting methods
- connectors

Environmental properties

Environmental testing ensures that RIM products can withstand both typical and extreme real-world conditions.

During environmental testing, RIM takes a representative sample of its radio modems and subjects it to a variety of harsh conditions. RIM measures over 100 digital RF calibration parameters, before and after each test. The difference between these measurements precisely reveals any performance degradation. Each unit in the sample is also visually inspected after testing. This experience enables RIM to fine-tune its design and manufacturing process.

Storage temperature

The RIM 902M radio modem can be stored at a temperature from -40°C to 85°C (-40°F to 185°F).

Operating temperature

The RIM 902M Radio Modem operates between -30°C to 70°C (-22°F to 158°F). The end user should be careful not to exceed the upper temperature limit, as performance degradation or damage to the power amplifier can occur past this point, especially during transmission.

The radio contains a temperature sensor that shuts off the transmitter automatically if the temperature reaches approximately 75°C (167°F).

Physical properties

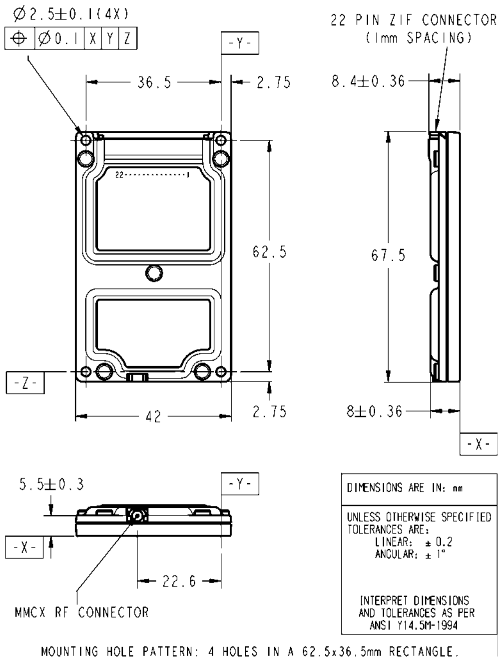
Weight

The RIM 902M Radio Modem weighs 35 g (1.2 oz), including the case.

Dimensions

RIM radio modems meet stringent space requirements. The maximum dimensions of the radio modem, not including cables, are:

- Width: 42.0 mm (1.65 inches)
- Length: 67.5 mm (2.66 inches)
- Thickness: 8.4 mm (0.33 inches)



Mounting methods

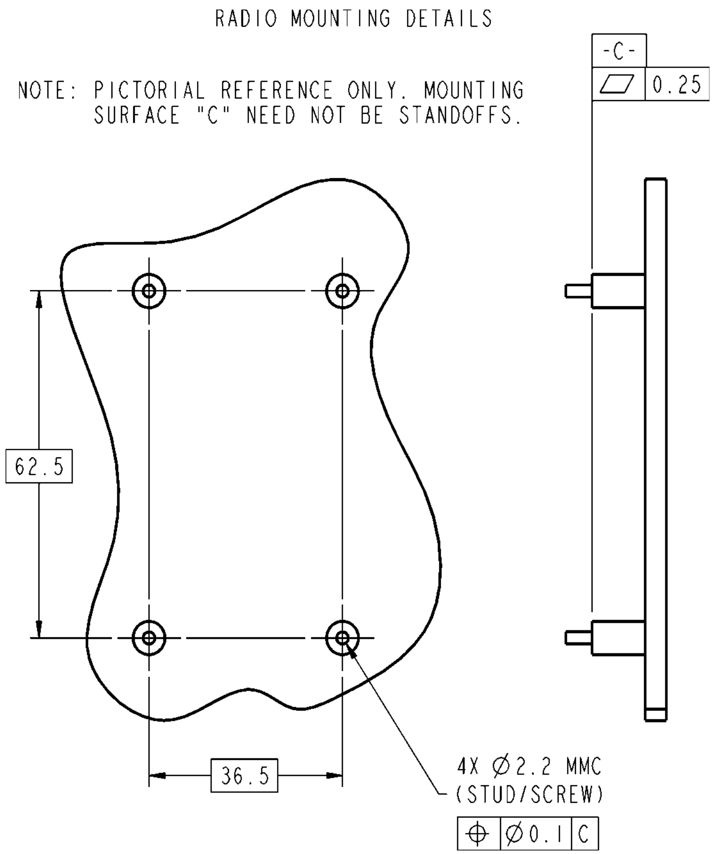
RIM radio modems can be fastened securely using a variety of methods. You must consider the operating environment when choosing a mounting option. For example, extreme temperature, heavy vibration, or high electromagnetic interference areas can require a special mounting solution. You must ensure that the radio modem remains securely attached in the environment where it is used.

The following information is presented as a guide, but applications can vary considerably. A mechanical engineer can help to ensure that the mounting method is suitable for the specific application.

Bolts or standoffs

The radio modem includes a hole in each corner, which can be used to bolt the device onto a circuit board, device housing, standoffs, or other surface. The mounting hole pattern is four holes in a 62.5-by-36.5 mm rectangle, with each hole 2.5 mm in diameter.

To allow room under the radio for components on your board, you can use standoffs instead of bolts, as illustrated in the following diagram.



Tie wraps

Tie wraps can be used as a secure but non-permanent means of attaching the radio modem to a surface. Typically, each tie wrap passes through a hole drilled into the surface of the board, on either side of the radio modem. This enables the radio to be attached to a shell, a PCB, or some other mounting surface.

If you are using tie wraps, ensure that the surface beneath the RIM 902M Radio Modem is flat. Otherwise, the mounting surface can push up on the bottom surface of the radio case, and the tie wraps, when tightened, can push down on the edge of the radio case. This pressure can cause the metal case of the radio modem to flex upward and to short components inside the radio. To avoid such malfunction, thick adhesive foam tape and tie wraps should not be used together.

Permanent industrial adhesive

RIM radio modems are small and lightweight enough to be attached to the host device using an industrial adhesive. For some applications, this method of mounting is preferable to bolts, because adhesive is easier to use in a manufacturing environment, and is more resistant than loosening than bolts. In many cases, an effective solution is to adhere the radio modem to the inside surface of your product’s casing.

Choose an adhesive based on its ability to stick to the material used in the outer casing of the radio modem and to the surface to which the radio will be mounted. The bottom casing of the RIM 902M Radio Modem is magnesium.

3M manufactures VHB, a permanent industrial adhesive with excellent long-term holding power. The peel adhesion and tensile holding power of VHB tapes are extremely high, making this a suitable solution when the radio does not need to be removed. Choose foam tape for rough surfaces and adhesive tape for smooth surfaces.

More information about VHB can be obtained by contacting 3M Industrial Tape and Specialties Division at 1-800-227-5085 (fax: 1-612-733-1771). The publication number for the VHB technical data sheet is 70-0702-0266-1(104.5)R1.

Cables and connectors

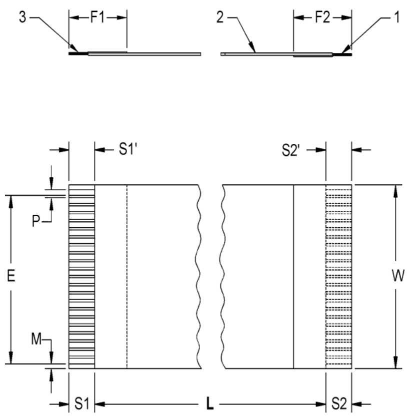
The radio modem has two connectors. One connector interfaces the radio modem to a serial computing device and a power supply. A second connector connects an antenna to the radio.

Interface cable and connector

Serial communication data, control signals, and power are carried on a flat 22-conductor 0.30 mm (0.012 inches) thick flexible printed circuit (FPC) cable with 1-mm centerline spacing, which can plug into a matching connector. Since each application is unique, Molex can create a custom Flat Flex Cable (FFC) Jumper in the correct length with the correct connector orientation for your application. The minimum cable length available is 30 mm (1.181 inches). Contact Molex at `http://www.molex.com`.

The interface cable supplied with the Integrator's Kit is a Type D 76.2 mm (3.0 inches) long FFC Jumper in 1-mm centerline spacing, Molex part number 210390382, as illustrated in the following mechanical drawing:

DEFINITION FFC TYPE D:



CHARACTERISTICS

ITEMS	VALUE	TEST METHOD
RESISTANCE OF CONDUCTOR	300 Ohm/km MAX	–
INSULATION RESISTANCE (CONDUCTOR TO CONDUCTOR)	10 M Ohm/km MIN	500 V DC
DIELECTRIC TEST (CONDUCTOR TO CONDUCTOR)	1 MINUTE	400 V AC
TEMPERATURE RATING	80°C	–
VOLTAGE RATING	30 V AC MAX	–
FLAME RESISTANCE	VW - 1	UL 158

THIS PRODUCT HAS BEEN APPROVED BY UL UNDER UL STYLE 2896
CABLE FILE NUMBER E45D46

COMPOSITION

ITEMS		SPECIFICATIONS	REF
CONDUCTOR	MATERIAL	TIN PLATED COPPER (0.002 mm MIN)	1
	DIMENSIONS	0.7 x 0.1 mm NOMINAL	
INSULATION	MATERIAL	POLYESTER + FLAME RETARDANT ADHESIVE INSULATION	2
	THICKNESS	0.11 NOMINAL	
REINFORCEMENT TYPE	MATERIAL	POLYESTER	3
	THICKNESS	0.23 NOMINAL	

DIMENSIONS

ITEMS	SPECIFICATIONS
NUMBER OF CONDUCTORS	22
PITCH P	1 ±0.1
SPAN E	21 ±0.15
TOTAL WIDTH W	22.9 ±0.15
MARGIN WIDTH M	0.6 ±0.2
STRIP LENGTH S1	4 ±1
STRIP LENGTH S2	4 ±1
END THICKNESS T	0.3 ±0.05
INSULATED LENGTH L	69 ±3
REINFORCEMENT LENGTH F1	9 ±2
REINFORCEMENT LENGTH F2	9 ±2
END SQUARENESS S-S'	0.3 MAX

DIMENSIONS ARE IN: mm

UNLESS OTHERWISE SPEC. TOLERANCES ARE:
.XX = ± 0.025
.X = ± 0.1
ANGLES = ± 0.5°

SURFACE FINISH 1.6

This cable can plug into a matching 22-position 1.0 [0.039] horizontal FPC connector. AMP / Tyco Electronics manufactures a variety of connectors, including AMP part number 2-487951-2. More information about each connector, including mechanical drawings, is available from the manufacturer’s web site (`http://www.amp.com`).

Contact RIM (oemsupport@rim.net) for help selecting an appropriate connector for your application.

Antenna cable and connectors

The RIM 902M Radio Modem uses the industry-standard MMCX connector because it is very small, and it has the mating force to withstand heavy vibration.

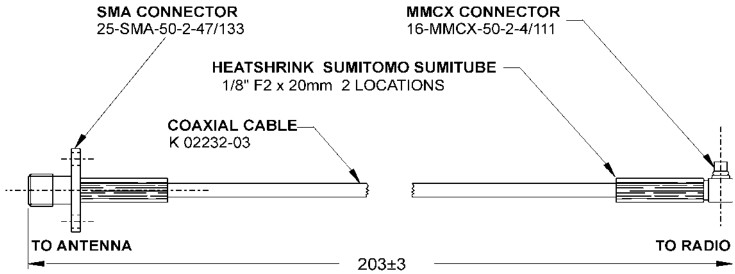
Typically, an antenna does not plug directly into a RIM 902M Radio Modem. Instead, a cable is used between the radio's antenna connector and a second connector at the outer casing of the device. This allows the antenna to be removed from the system without opening the device, and it eliminates a source of strain on the radio's MMCX connector.

The antenna cable should have low loss, an impedance of 50 Ω, and an MMCX jack that mates with the RIM 902M Radio Modem's MMCX plug. The other end of the cable can be any connector with an impedance of 50 Ω. An SMA screw-on connector is suitable and widely available. TNC connectors are also suitable, but larger than SMA. The antenna cable supplied with the Integrator's Kit has an MMCX connector on one end and an SMA connector on the other. The cable is built with strain reliefs to prevent damage.

Huber & Suhner provide antenna cables and connectors. Visit `http://www.hubersuhnerinc.com` for more information. The parts described below have an impedance of 50 Ω and are suitable for use with the RIM 902M Radio Modem.

The following cable is included with the Integrator's Kit:

11MMCX-50-2-1C / 111	Straight MMCX connector
16MMCX-50-2-1C / 111	Right-angle MMCX connector
25SMA-50-2-25 / 111	SMA connector
EZ Flex 405	Low-loss matching (50 W) cable
133REEZ4-12-S2 / 1216	8" cable, straight MMCX to SMA
133REEZ4-12-S2 / 1699	8" cable, right-angle MMCX to SMA



DIMENSIONS ARE IN: mm

UNLESS OTHERWISE SPEC.
TOLERANCES ARE:
.XX = ± 0.025
.X = ± 0.1

NOTES:

1. MANUFACTURER: HUBER & SUHNER AG.
2. MANUFACTURER'S PART NUMBER: 99003361

4
Power requirements

The RIM 902M Radio Modem requires a clean power source capable of delivering bursts of high current. This power source can be provided by a plug-in power supply unit, a rechargeable battery pack, or by single-use batteries. RIM has conducted extensive research to develop guidelines for integrators who design the power supply system for the radio modem.

Load specifications

The radio modem draws its power in bursts; the power required changes rapidly depending on whether the radio is transmitting, receiving, or in standby mode. The load profile is provided on the following page. These specifications can be given directly to your power supply designer or battery supplier.

Power supply parameters

The RIM 902M Radio Modem requires a clean, stable 4.1 V to 4.75 V source that is capable of delivering a 1-second burst of up to 1.7 A (at 4.5 V) when required by the transmitter. Maximum efficiency is obtained at 4.1 V. RIM recommends designing a more robust power supply that can provide adequate power under such non-ideal conditions as an improperly matched antenna, under which this burst could be as high as 2.2 A. The receiver current consumption is 54 mA. The standby current consumption is less than 0.2 mA in “deep sleep” mode, and 5.5 mA in regular standby mode.

Radio load profile (at 4.5 V)

Component	Load
Transmitter: – transmitting 2 W to antenna – worst-case peak	 1.7 A 2.2 A
Receiver	54 mA
Regular standby	5.5 mA
Low-power standby	< 0.2 mA
Transmit duration – minimum... – maximum…	 32 ms 960 ms
Off current consumption	≤ 20 µA
Overall power consumption (based on heavy usage of 0.05% transmit, 5.00% receive, 94.95% standby): – if low-power standby is used – if low-power standby is not used	 3.7 mA 8.8 mA

Ripple specification

For best performance, ripple of less than 15 mV peak-to-peak (measured at the radio end of the connector) is recommended across the frequency range 60 Hz to 1 MHz. The maximum ripple at the connector that can be tolerated is 20 mV peak-to-peak.

Except in special cases where there are several sources of ripple, you measure the ripple with an oscilloscope set to 1-MHz bandwidth, and the peak-to-peak value is not to exceed 15 mV. Note that if there are several ripple components, or if ripple is measured with a larger (typically 20-MHz) bandwidth, the ripple seems worse. If the ripple is still below 15 mV under these conditions, it meets the ripple specification.

A passive LC (series L, shunt C) power filter can be put between your power supply and the RIM 902M Radio Modem to reduce ripple at the radio connector. The radio modem already has about 70 µF of on-board shunt capacitance. The inductor cannot exceed 100 µH (otherwise, transients could reset the radio), it must be rated to pass the maximum DC current of 2.2-A supply current at all temperatures, and its resistance must be low enough to guarantee minimum voltage of 4.1 V to the radio modem at 2.2 A.

Reducing power consumption

To maximize battery life, the RIM 902M Radio Modem provides two methods of reducing power consumption during idle time.

Powersave mode, which is the default state of the radio modem when it is turned on, allows the receiver to automatically shut off when the radio does not expect to receive data from the base station. This reduces standby consumption to 5.5 mA. The radio turns on its receiver briefly during scheduled “windows.” The base station only attempts to communicate with the radio during these windows. To minimize latency during rapid 2-way communication, the receiver is also turned on and kept on for 10 seconds following any communication (transmit or receive) with the network.

Low-power mode, which is not the default state of the radio modem when it is turned on, also turns off the radio’s 386 microprocessor between operations. This reduces standby current consumption to less than 0.2 mA. The 386 microprocessor is activated by events, such as a countdown timer to the next receive window, or activity on the serial port.

Powersave and low-power mode can be enabled or disabled through the RAP interface.

Note	The only tradeoff with using Powersave is increasing the receive latency. Powersave does not increase the latency of transmitting data from the radio, which always takes place as soon as possible.

Calculating overall power consumption

The instantaneous power consumption varies between 0.2 mA and 1.7 A, a range of four orders of magnitude. At any given point in time, the power consumption depends on what the radio is doing. Calculating the overall power consumption is important in selecting a battery with the appropriate capacity.

The current figures below are all measured at a supply voltage of 4.5 V. The actual operating range of the supply voltage is 4.1 V to 4.75 V.

Transmitter power usage

The radio transmitter draws 1.7 A to transmit 2.0 W, which is the maximum output power possible. The radio reduces the output power automatically to the minimum required to be heard by the base station; this reduces the current requirement. The minimum output power is 60 mW and typically occurs when the radio is very close to a base station. The maximum duration of a transmit pulse is 960 ms (required to transmit 512 bytes of user data) and the minimum is 32 ms (required to transmit 1 byte of user data, or to acknowledge a received data packet). Use the following calculation to determine the actual time, in milliseconds, that the transmitter is on (where *n* is the number of user data bytes):

```
int((n+33)/18)*32 (HPDATA type MPAK)
int((n+34)/18)*32 (TEXT, DATA, or STATUS type MPAK)
```

When the radio is not transmitting, the transmitter is off and consumes no power.

Receiver power usage

The RIM 902M Radio Modem receiver draws 54 mA when it is turned on. However, in Powersave mode, the receiver is nearly always turned off, and is turned on only once every ten seconds. The base station waits until the radio’s receiver is turned on before attempting to send data to the radio. The radio leaves the receiver on for just 0.2 seconds; if no data is waiting at the base station, the radio turns off the receiver for

9.8 seconds. This process reduces power consumption significantly, but introduces a latency of up to 10 seconds when receiving data packets from the wireless network. (It is possible to further reduce power consumption by voluntarily increasing the latency from 10 seconds to 20, 40, 80, or 160 seconds, using the RAP Set Skipnum frame. Refer to the *RAP Programmer Guide* for more information.)

The receiver also stays on for 10 seconds (the "transaction time") immediately after data is sent to or received from the network base station. During the transaction time, there is no latency introduced by the use of Powersave mode. This lack of latency allows 2-way interactive applications to process a transaction without delay. It also means that sending 3 packets in rapid succession consumes less power than sending 3 packets more than 10 seconds apart.

To decide whether to roam onto a new base station, the radio periodically scans frequencies of neighboring base stations. The length of time spent scanning is difficult to predict, as it depends on coverage, user mobility, and number of network channels. Most applications spend less than 0.2% of the time scanning, during which the receiver is turned on.

When the radio roams onto a new base station, the receiver is typically on for 5.5 seconds and the transmitter is on for 47 ms. Therefore, a highly mobile application consumes more power than one in a semi-fixed location.

Power consumption examples

The following usage models illustrate some typical scenarios. These are very approximate calculations intended to help select a battery for a first prototype, and are not intended to replace an empirical determination of battery life. A number of assumptions are made: all transmission is at the maximum output of 2 W, more than 10 seconds elapse between each transmission or reception, all messages are successfully sent after the first attempt, an 8-hour day is used, and low-power standby mode is used. (Add approximately 5 mA if low-power standby mode is not used.)

Traffic in 8 hours	No data	Light	Medium	Heavy	Extreme
Received packets	0	5	30	80	150
Transmit packets	0	5	10	25	50
Length of packets	0	80	300	300	512 bytes
Number of roams	0	10	15	20	40
Load profile					
Receiver on	2.200	2.726	3.838	6.138	9.735 %
Transmitter on	0.000	0.006	0.026	0.062	0.190 %
Low-power standby	97.800	97.268	96.136	93.800	90.076 %
Average current	**1.38**	**1.76**	**2.70**	**4.56**	**8.66 mA**

Batteries

When integrated into a handheld device, the RIM 902M Radio Modem can be powered by batteries. This technology is easily available and eliminates the need for power supply components such as voltage regulators.

Rechargeable batteries

RIM recommends using rechargeable nickel cadmium (NiCad) batteries to power the RIM 902M Radio Modem for battery-operated applications that require a wide operating temperature range. Nickel metal hydride (NiMH) and lithium ion (Li+) cells can also be used with good results, but many such cells do not work very well at temperatures below freezing. Specifications for batteries should be obtained from the manufacturer. The RIM engineering development team (oemsupport@rim.net) can help you determine whether a particular battery is suitable for your application.

The selected cells must be able to meet the load specifications of the radio modem. Specifically, they must be able to provide 1.7 A (at 4.5 V) for transmission. Rechargeable cells vary considerably, because capacity varies with current draw. Even if two cells have the same published capacity, one might not be as efficient as another when the radio transmitter is turned on. This is because some batteries have a higher equivalent series resistance (ESR) at high current drain. The ESR should be low enough that the battery can supply the transmission current required without a large voltage drop.

Rechargeable alkaline batteries are another option. These cells are typically rated for about 25 discharge cycles, far fewer than NiCads, but they provide longer life than NiCads. For the first five to ten cycles, you will receive about 70 to 80 percent of the battery life you would expect from a single-use alkaline cell. After 25 discharges, this number may drop to 50 percent. Some precautions must be taken with this type of battery. These cells are not intended to be used to their full capacity, so the actual useful runtime of these cells is closer to 30 to 40 percent of a single-use alkaline cell, and requires the user to pay closer attention to the state of the batteries. If you fully discharge a rechargeable alkaline battery, you may only get five recharges before the capacity decreases to the point where it is useless.

Single-use batteries

Among single-use cells, only alkaline and lithium cells provide the high current necessary for transmission. In particular, AA alkaline cells are inexpensive, widely available, and provide an excellent power source. Alkaline cells typically run about four times longer than similar-size NiCad cells, and about three times longer than similar-size NiMH cells.

The use of general-purpose carbon-based batteries is strongly discouraged, as this type of battery is unable to supply the power required by the transmitter. These cells are more suited to flashlights and other products that do not have a bursty load characteristic. If a carbon-based battery is used, the voltage drops below the minimum power required under load almost immediately following a radio transmission, which resets the radio each time it tries to transmit.

You should recommend to your customers to use single-use batteries in your product that are clearly identified as alkaline.

Plug-in supplies

A plug-in supply converts normal AC power (usually 110 V or 220 V) into a steady DC source that can be used instead of batteries. The plug-in supply must be designed to ensure that voltage spikes, lightning, and other power fluctuations cannot damage the radio modem. Transient voltage protection zener diodes, or other spike arrestor circuits, can be added to keep the inputs within the limits given in the radio modem load specifications. These should have a value of 20 V and be placed on the supply side of the regulator circuit.

RIM recommends a supply capable of providing 4.1 V and rated for 2.5 A peak current.

Automotive supplies

If you plan to power the RIM 902M Radio Modem from an automotive supply, special steps must be taken to protect the radio modem from intense power fluctuations experienced when an automobile is started. A circuit comprising inductors, transorbs and voltage regulators should be used to ensure that the radio modem is protected from these power fluctuations.

Commonly, in automotive applications, voltages may be as high as 70 V on the battery, especially on startup. Commercial automotive adapters are available that will safely convert the 12 V automotive supply to a regulated supply suitable for operating the RIM 902M radio modem.

LIND Electronics (`http://www.lindelectronics.com`) can supply a car lighter adapter suitable to drive a 5V, 2A device (model number APA-SH0520M) with a connector of your choice; your hardware should then reduce the power to 4.1 V.

5
Interface specification

The asynchronous serial interface on the RIM 902M Radio Modem operates at 3 V, making it compatible with many existing system designs. The radio modem can be controlled by a wide variety of microcontrollers and microprocessors, such as the Intel 8051 or 80386, or Motorola 68000. In most cases, you can connect the radio modem directly to a micro-controller, or through a Universal Asynchronous Receiver / Transmitter (UART) to a microprocessor data bus. If the radio modem is to be connected directly to a computer or other RS-232 device, an interface must be provided to convert the signal voltage to the higher values required by an RS-232 device.

Link-layer protocols

Note	This section applies if you control the radio using an external processor. A link-layer protocol is not required if you develop an embedded application using the *Software Developer's Kit*.

The RIM 902M Radio Modem requires a serial link-layer protocol to carry data, radio control instructions, and radio status information between the radio modem and the computing device to which it is attached.

The RIM 902M Radio Modem supports two protocols: Mobitex Asynchronous Communication (MASC) and RIM Radio Access Protocol (RAP).

If you are using a MASC application with another Mobitex radio and are now migrating to the RIM 902M, you do not need to rewrite the application in RAP. You can continue using the existing MASC application. If you are writing a new application for the RIM 902M Radio Modem, you must choose whether to use MASC or RAP as your link-layer protocol.

MASC assumes a high-noise environment where bit errors are likely to occur on the serial link between the radio modem and the computing device. MASC.

Advances in mobile computing technology have helped to ensure that serial links are short enough to make bit errors extremely unlikely. This is especially true for smaller devices such as laptops and personal digital assistants (PDAs). The complexity of MASC is unnecessary for these applications, and involves complex and lengthy software development.

RAP was designed to take advantage of the reliability inherent in a short serial link. The primary benefit of RAP is that it is easy to describe and implement. As a result, RAP reduces software development time, complexity, and memory consumption. It also provides twice the throughput of MASC, by using binary frame data transfers instead of hex-ASCII encoding.

Since every application is different, the choice of protocol should be made carefully. The following chart is provided as a guide to comparing the relative advantage of each protocol.

Criteria	MASC	RAP
Interface cable from the radio modem to device	Designed for long serial cable; prone to bit errors	Assumes a short, reliable serial cable
Operating environment	Withstands harsh, hostile electrical interference	Best suited for laptops, PDAs, other small devices
Software complexity	Complex	Simple
Implementation time (typical)	Weeks or months; or use third-party APIs	Days
Memory requirements	10 to 50 KB	1 to 3 KB
Hardware flow control	RTS/CTS is required	RTS/CTS is optional

Throughput at 9600 bps	4800 bps	9600 bps
Cost	Free, open specification; or pay for third-party APIs	Free, open specification; sample source code is free

Both MASC and RAP are used strictly for the link between the radio modem and the computing device. The choice of protocol does not have any influence on the speed or reliability of communication between the radio and the Mobitex wireless network. The reliability of the serial interface connecting the RIM radio modem to your computing device determines which link protocol to use. If required, the RIM engineering development team (oemsupport@rim.net) can help you select the protocol most suited to your needs.

Software Developer's Kit

Note This section applies if you are developing a resident application using the RIM Software Developer's Kit (SDK). The SDK is not required if you are controlling the radio through an external processor.

The RIM 902M Radio Modem is based on a 32-bit Intel® 386 processor, which you can use to run third-party applications residing on the device. Memory available for your resident application includes approximately 110 KB of SRAM, 448 KB of EPROM (flash memory) file space, and 320 KB of application code space. Additional resources include a second serial port and four bidirectional I/O lines.

The Software Developer's Kit provides a powerful development environment that uses Microsoft Developer Studio 6.0 or later (Visual C++ 6.0 or later), on a Windows platform. The radio modem platform is well suited for object-oriented programming because it is managed by an event-driven, multi-tasking operating system that controls applications running on the modem's internal Intel 386 processor.

The RIM Radio Modem simulator enables you to use a standard PC to develop software applications quickly. When fully tested and debugged, you can download the compiled application into the RIM radio modem without any required modifications.

For further information on how to take advantage of this on-board programming capability, refer to the *SDK Developer Guide*, included in the Software Developer's Kit, or email oemsupport@rim.net.

Pin descriptions

All input and output lines are 3 V logic; however, they can also drive 3.3 V systems. Input lines 13, 16, 19, and 20 are 5 V input tolerant. Output lines can drive 5 V systems, as long as the V_{IH} of these pins is less than 2.5 V.

All outputs source a short circuit current of 3 mA. Inputs have a current leakage of 1 µA.

This section describes each of the 22 lines that comprise the interface to the RIM radio modem. The symbol ~ before the label indicates that line is an active low digital signal.

The radio modem has two serial ports. The primary serial port uses pins 20 and 21 to transmit and receive RAP or MASC data between the radio modem and the computing device. The secondary serial port uses pins 13 and 22 to transmit and receive data, for custom, on-board applications, not for RAP or MASC traffic. Flow control lines are provided for the primary serial port only.

Pins 9 through 22 on the RIM 902M Radio Modem correspond to pins 14 through 1 on the RIM 900 Radio Modem. The numbering is reversed because the connector is reversed, but physically the leftmost pin on the RIM 902M connector is the same as the leftmost pin on the RIM 900 connector.

All unused inputs to the radio should be grounded, and any unused outputs from the radio should be left disconnected.

Note On the RIM 902M Radio Modem, pins labelled TX are input lines to the radio; pins labelled RX are output lines from the radio.

PIN #	Label	Description
1,2,3,4	—	Bidirectional I/O lines
5	MSG	Message Waiting
6	COV	Coverage
7, 8	POWER	Power
9	GND	Ground
10	TURNON	Turn Radio On
11	ONI	On Indicate
12	TRI	Transmit Indicate
13	TX2	Secondary Transmit
14	~RI	~Ring Indicate
15	~CTS	~Clear To Send
16	~RTS	~Request To Send
17	~DSR	~Data Set Ready
18	GND	Ground
19	~DTR	~Data Terminal Ready
20	TX	Transmit
21	RX	Receive
22	RX2	Secondary Receive

Pins 1, 2, 3, 4 Bidirectional I/O lines

These lines are individually configurable as input or output by using the `_inp()` function provided by the Software Developer's Kit (SDK).

These lines are meaningful only to an application that resides on the RIM 902M and is developed using the SDK. These lines are never used in a RAP or MASC interface to an external computing device.

If a line is set as an output, it may be strongly driven by the application to 0 or 1.

If a line is set as an input, it may be used either as a high impedance input or an open drain output, as determined by the application.

For more information about the use of these pins, refer to the *SDK Developer Guide*.

Pin 5 MSG Message Waiting

This line is an output from the radio modem.

The active state of this line is high, and indicates that the radio modem has received an MPAK from the network, which has not been delivered to the device application yet. This line remains active until the application acknowledges receiving the packet.

When the radio modem receive buffer is full, this line is inactive (low).

Pin 6 COV Coverage

This line is an output from the radio modem.

The active state of this line is high, and the radio modem is within network coverage, as determined by the presence of a signal from the network base station.

When the radio modem does not have contact with the wireless network, this line is low.

Pin 7, 8 POWER Power supply

These pins supply power to the radio modem. Since the current requirement during transmission exceeds the current rating of a single line, both lines 7 and 8 should be connected to the power supply.

Pin 9 GND Ground

This line should be tied to the system ground of the computing device to ensure proper operation. Pin 18 should also be connected to ground.

Pin 10 TURNON Turn Radio On

This line is an input to the radio modem.

This line turns on the radio modem. It is a digital signal that eliminates the need for an on / off switch for the power supply to the radio modem. This is a 3 V input to the radio modem, and is not 5 V tolerant.

Pin 11 ONI On Indicate

This line is an output from the radio modem that indicates that the modem is on and operational.

This line can be used by a computing device to qualify the handshaking outputs on the serial interface. If CTS is low, and ONI is high, then the unit is ready to receive data, but if CTS is low and ONI is low, then the radio modem is not ready to receive data because it is off.

When ONI is low, all inputs to the radio modem should be held low or disconnected. Otherwise, power is consumed and wasted.

Pin 12 TRI Transmit Indicate

The active (radio transmitting) state of this line is high.

This output from the radio modem is asserted while the RIM radio is transmitting a packet to the network base station. TRI has a built-in current limiter that enables it to drive an LED directly, to provide real-time visual feedback that the radio is transmitting packets. If this is not necessary, you can leave the line disconnected.

This line supplies 3 mA to a standard LED, and is short-circuit protected. This line is low when the radio modem is off.

Pin 13 TX2 Secondary Transmit

This line is an input to the radio modem. Its idle (no serial transmit activity) state is high.

This line is an asynchronous serial input to the radio modem, and may be connected to a computing device's Transmit Data output. This line carries data at 9600 bits per second, 8 bits, No parity, 1 stop bit.

This line is meaningful only to an application that resides on the radio modem and that was developed using the SDK. It enables the application to transmit data to a second serial device. No flow control lines are provided for this second device. This line is never used in a RAP or MASC interface to an external computing device.

For more information about the use of this pin, refer to the *SDK Developer Guide*.

Pin 14 ~RI ~Ring Indicate

This line is an output from the radio modem.

When ~DTR is not asserted (high), the radio modem asserts ~RI (low) to indicate that it has data waiting for the computing device. The radio modem does not transfer the data until ~DTR is asserted (low). This line can be used to wake up a suspended computing device when the radio modem needs to communicate with it. If ~DTR is already asserted (low) when the radio modem has data to send the computing device, ~RI is not asserted.

For MASC implementations, this line indicates that the radio modem has a MASC frame waiting to transfer to the computing device. This line may be left disconnected if your application does not use it.

For RAP implementations, ~RI is not used and should not be connected.

Pin 15 ~CTS ~Clear To Send

This line is an output from the RIM 902M Radio Modem to the computing device. The active (clear to send) state of this line is low.

When asserted low by the RIM 902M Radio Modem, this line indicates that it is ready to receive data from the computing device. While this line is high, any data sent from the computing device to the RIM 902M Radio Modem may be lost. This line is a flow control mechanism that is normally reacted to by the UART in your serial communication system. If you do not plan to use it, leave ~CTS disconnected.

Pin 16 ~RTS ~Request To Send

This line is an input to the radio modem. The active (request to send) state of this line is low.

All MASC implementations require this line, but it is optional for RAP implementations. It should be asserted low by the computing device to indicate that it is ready to receive data from the radio modem. This is a flow control mechanism that is normally handled by the UART in your serial communication system. If you do not connect this line to your UART, it must be tied low so that it is permanently asserted and enables communication.

If your device's buffer overflows, it should set RTS inactive to signal the radio modem to pause in sending data. There might be a 16-byte overrun after the RTS line is made inactive, so your device should set RTS inactive at least 16 bytes before any critical buffer overflows.

Pin 17 ~DSR ~Data Set Ready

This line is an output from the radio modem. It is electrically connected to ~DTR.

The active, or data set ready (DSR), state of this line is low. Your computing device can use DSR as a confirmation that the radio modem knows the state of the terminal. DSR follows DTR, so the two lines are always at the same voltage.

Pin 18 GND Ground

This line should be tied to the system ground of the host unit to ensure proper operation. Pin 9 should also be connected to ground.

Pin 19 ~DTR ~Data Terminal Ready

This line is an input to the radio modem.

The active, or data terminal ready (DTR), state of this line is low, and indicates that the computing device is ready to receive data from the RIM 902M Radio Modem. De-asserting this line high turns communication off; the radio modem does not attempt to deliver data to the computing device until ~DTR is again asserted low. Asserting this line low will cause the radio to send a MASC B-frame to the computing device if MASC is the protocol being used, and allows communication to resume.

If you do not intend to use ~DTR, tie it to ground to ensure that it is always asserted during radio modem operation.

This line should be driven low when the radio modem is off. Driving ~DTR high when the radio modem is off will consume unnecessary power.

Pin 20 TX Transmit

This line is an input to the radio modem. Its idle (no serial transmit activity) state is high.

This line is an asynchronous serial input to the radio modem, and should be connected to the computing device’s Transmit Data output. This line carries data at 9600 bits per second. MASC parameters are 7 bits, Even parity, 1 stop bit. RAP parameters are 8 bits, No parity, 1 stop bit.

Pin 21 RX Receive

This line is an output from the radio modem. Its idle (no serial receive activity) state is high.

This line is an asynchronous serial output from the radio modem, and should be connected to the host terminal’s Receive Data input. This line carries data at 9600 bits per second. MASC parameters are 7 bits, Even parity, 1 stop bit. RAP parameters are 8 bits, No parity, 1 stop bit.

Pin 22 RX2 Secondary Receive

This line is an output from the radio. Its idle (no serial receive activity) state is high.

This line is an asynchronous serial output from the radio modem, and may be connected to a computing device's Transmit Data output. This line carries data at 9600 bits per second, 8 bits, No parity, 1 stop bit.

This line is meaningful only to an application that resides on the RIM 902M and developed using the SDK. It allows the application to receive data from a second serial device. No flow control lines are provided for this second device. This line is never used in a RAP or MASC interface to an external computing device.

For more information about the use of this pin, refer to the *SDK Developer Guide*.

How to turn the radio on and off

The TURNON pin is a digital signal that turns the radio on and off. It eliminates the need for a power switch across the power supply to the radio modem.

Turning on the radio

To turn the RIM 902M radio modem on, the software should first check the ONI pin. If ONI is high, but TURNON is being held low, then your application has recently requested the radio modem to shut down, and the radio is performing shutdown operations and should not be disturbed. Wait for ONI to go low before continuing.

If ONI is low, this indicates the radio modem is turned off. Set the TURNON line high to turn the radio on. The ONI pin will respond by going high, typically within 2 seconds. Once the ONI pin is high, other handshaking and communication signals can begin.

If the radio modem fails to respond to a high TURNON line, the radio modem may require service, or the power supplied to the radio may be too low for proper operation.

Turning off the radio

A controlled shutdown is necessary to allow the RIM 902M radio modem to tell the Mobitex wireless network that it is off air. To turn the RIM 902M radio modem off, your software should de-assert the TURNON line by setting it low. The radio modem will then begin shutdown operations, and the ONI pin will remain active until all shutdown operations are complete.

Shutdown may require several seconds to complete, and the radio modem should not be disturbed while it is shutting down. Attempting to communicate with the radio modem during shutdown may extend the time taken to perform shutdown operations. The ONI signal will be de-asserted (low) when the radio has shut down.

All inputs to the radio modem should be low when it is turned off. This way, power consumption will be reduced to the lowest possible levels. Note that if any line is left in the high state, as much as 5 mA may flow into the radio modem.

Data that has been received by the RIM 902M radio modem from the Mobitex network, but has not been transferred to the computing device, will not be saved. The packets will be lost when the unit enters shutdown or is turned off.

Following this shutdown procedure, the radio modem continues to draw less than 0.2 mA. It is not necessary to remove power from pins 7 and 8, unless the application is so power constrained that it cannot tolerate the current draw of less than 0.2 mA that occurs when the radio modem is shut down.

Resetting the radio

It is recommended that integrators incorporate a method to remove power from pins 7 and 8 on the radio modem during the development and prototype phase. This will enable the device to perform a hard reset of the radio modem, which can be useful in some debugging testing situations.

Loading firmware (optional)

RIM firmware controls the operation of the radio modem. RIM is committed to the quality of its firmware, and improvements or optimizations may be made from time to time. The radio modem is designed so that loading revised firmware is not required; two RIM 902M radio modems with different firmware revisions will always be able to communicate with each other, and with the same fixed servers, through the wireless network. Nevertheless, you may choose to design your application in such a way that allows the RIM firmware to be updated after your product is deployed in the field.

Because of its large size, firmware cannot be updated over the air. If you decide to implement the ability to update the firmware after the radio modem is deployed, RIM can provide a DOS programming utility that loads firmware into the radio modem. If your device is not DOS-based, the programming utility must reside on a PC or laptop that is connected through its COM port to the radio modem's RX and TX lines. This means that the RX and TX lines would be brought out to an external connector, and a switch required to select whether the radio modem is connected to your processor or to the external programming computer. Other lines that are required during reprogramming are DTR (must be asserted low), TURNON (must be asserted high), and GND.

This external serial port will can also be useful for FCC certification testing, and it is highly recommended that this be incorporated into at least one device designated for testing purposes.

Applications on the radio created with the SDK that open the serial port upon start-up and never close it will disrupt the ability for the radio to communicate serially. Aside from the physical switch described above, a software algorithm may also be incorporated into the application to release the serial port for loading new versions of an application, testing, etc. An example follows:

- There must be a specific command or control string that will reset the radio and run a "dummy" application that does not open the serial port:
- Establish a flag to be used to indicate the method of operation of the radio, e.g. 0 for Normal, 1 for Testing. This can either be a software flag stored in flash, or a hardware flag, created through the use of one of the 4 extra I/O lines (pins 1-4).
- Upon startup, if flag=0 (normal) then run your normal application, which may or may not open the serial port. If the special control string or command is received, set the mode of operation flag to 1, and reset the radio.
- If flag=1 (testing) then run a dummy application which does not open the serial port. Change the mode of operation flag to 0, so that upon reset, the radio will default back to its normal mode of operation.

Alternatively, the product being used for testing can be programmed without an application.

6 Antenna selection

The antenna is one of the most important components of a wireless communication system. The right antenna will maximize the coverage area of the RIM radio modem.

The antenna that you choose should complement the needs of your specific project. There are many different antenna types and options that will meet your engineering and user requirements while remaining within budget constraints. We strongly recommend the use of an experienced antenna provider in order to realize the highest gain possible. A well-designed antenna solution will maximize efficiency, coverage area, and battery life.

Selecting an antenna

Antenna manufacturers have designed and manufactured a wide variety of antennas for use on the Mobitex network, and for other radio-frequency (RF) systems operating in the same frequency range. RIM does not recommend specific antennas because the choice of antenna is application-dependent.

The performance of an antenna depends on its configuration and environment: the same antenna will behave differently in one device than in another device, even if both devices use the same RIM radio modem. For example, magmount antennas include a magnetic base that allows the antenna to clamp onto a metal surface. This surface is called a ground plane, and it reflects electromagnetic radiation that would otherwise be lost to the antenna. This reflection effectively doubles the length of the antenna by creating a virtual “mirror image” of the antenna beneath the plane.

Antenna requirements

The following are the minimum requirements of the antenna system used with the RIM radio modem.

Impedance: 50 Ω

Center frequency: 913.5 MHz, ±5 MHz (λ=32.8 cm, ±0.2 cm)

This is deliberately biased toward transmit because of the exceptionally sensitive receiver in the radio; it helps balance the two-way link between the radio modem and the network base station.

Frequencies of operation: 896 to 902 MHz (transmit)
935 to 941 MHz (receive)

Acceptable return loss: VSWR < 1.5 or RL < –14 dB (recommended)
VSWR < 2.0 or RL < –10 dB (minimum acceptable)
This is required across the frequencies of operation.

Antenna supplier contact information

For information on antenna suppliers, visit the web site `http://www.rim.net/oem`.

Introduction to antenna terminology

This section introduces some of the terminology that is used to describe antennas, and expands on the summary of antenna requirements, above.

Gain and ERP

Antennas produce gain by concentrating radiated energy in certain areas, and radiating less energy in other directions. The amount of gain depends on the radiation pattern, antenna match, and antenna efficiency. Antenna gain is given as a rating of the maximum increase in radiated field energy density relative to a dipole antenna, expressed in decibels of power gain (dBd).

A dipole is a balanced antenna consisting of two radiators that are each a quarter-wavelength, making a total of a half-wavelength. The widespread use of half-wave dipole antennas at VHF and UHF has led to the use of a half-wave dipole as the reference element.

At the antenna port, the output power of the RIM 902M is 62 mW to 2.0 W The antenna gain (or loss) will result in an increase (or decrease) in the output power. The actual output from the antenna is called the Effective Radiated Power, or ERP. For example, if the RIM 902M radio modem is delivering 2.0 W of power to a 2.3 dBd gain antenna, the ERP is 2.0×10^$(2^{.3 \div 10}) = 3.4$ W, the actual power radiated by the antenna in the direction of maximum gain and polarization.

Impedance matching, return loss, and VSWR

The antenna, cables, and connectors in a radio frequency system must all possess the same impedance. The impedance required by the RIM 902M radio modems is 50 Ω, which is a widely-available industry standard. Any deviation from this value may result in impedance mismatch and signal loss.

Impedance mismatch can also be caused by cable connections, cable lengths, and imperfections in the cables and connectors. The mismatch causes some of the radio frequency energy to be reflected back from the location of the mismatch. This reflection interferes with the signal and reduces its amplitude, resulting in a power loss.

Antenna mismatch can be expressed as a Return Loss (RL), which is simply the ratio of reflected power to the incident power, expressed in decibels.

$$RL = 10 \times \log_{10}\left(\frac{P_{\text{reflected}}}{P_{\text{output}}}\right)$$

Equation 1: Return Loss

The Voltage Standing Wave Ratio (VSWR) is another way of expressing the ratio of incident power (from the radio modem) to reflected power (into the radio modem).

$$VSWR = \frac{1 + \sqrt{\dfrac{P_{\text{reflected}}}{P_{\text{output}}}}}{1 - \sqrt{\dfrac{P_{\text{reflected}}}{P_{\text{output}}}}}$$

Equation 2: VSWR

VSWR = 1 or RL = $-\infty$ dB is a perfect match. In practice, imperfections are inevitable, which means that VSWR will be greater than 1 and RL will be a negative number.

VSWR and RL normally vary as a function of frequency. The RIM 902M's frequency range includes 896 to 902 MHz (transmit) and 935 to 941 MHz (receive). minimum acceptable match across this range must be VSWR < 2.0 or RL < –10 dB. For best performance, the recommended antenna match at these frequencies is VSWR < 1.5 or RL < –14 dB.

Antenna size

An antenna measuring one wavelength, λ, produces optimal antenna radiation efficiency. The value of λ is 32.8 cm, and is calculated by dividing the speed of light $c = 3 \times 10^8$ m/s by the center frequency f = 913.5 MHz. Because the RIM 902M radio modem's receiver is so sensitive, this value includes a 5 MHz bias toward the transmit frequencies to help balance the uplink and downlink between the radio modem and the network base station.

Antenna lengths of $\lambda/2$, $\lambda/4$, and $\lambda/8$ also work well, and usually result in a relatively well matched antenna. $\lambda/2$ or $\lambda/4$ can be electrically "shortened" by adding load matching elements to control the antenna match. However, this shortening will reduce the antenna efficiency and, therefore, the effective radiated power.

Antenna design considerations

Proper positioning of the antenna will maximize the gain provided by the antenna. In determining the proper position, the designer must carefully consider the environment in which the device will be used. Physical devices can vary significantly, and incorporating the antenna is an integral part of a successful design.

The Mobitex network is based on vertically polarized radio-frequency transmission. Therefore, the antenna should be oriented so that it provides vertical polarization. This polarization is achieved by positioning the antenna vertically upward when the radio modem is in use. In small, hand-held devices, it may be convenient to design the unit in such a way that the antenna folds out of the way when not in use.

The antenna should be located as far from the active electronics of the computing device as possible. In general, metal construction in the case of the computing device and its internal components may attenuate the signal in certain directions. This is not desirable because it reduces the sensitivity and transmit performance of the radio modem when the computing device is held or positioned in certain orientations. However, the judicious use of metal in the construction of a ground plane for an antenna can significantly improve the antenna gain and the coverage area of the system.

If the computing device is designed to sit on a surface, then the antenna should be as far from the bottom of the device as possible. This will reduce radio-frequency (RF) reflections whenever the device is placed on a metal surface.

To prevent interference from the antenna into the radio modem during transmit, the antenna must be placed a minimum 2 cm (0.8”) away from the radio modem. For best performance, the antenna should be placed more than 5 cm (2”) away from the radio modem.

When the computing device is hand-held or is worn next to the body of the user, the antenna should be positioned to radiate away from the body. Otherwise, the body will absorb the radiated energy and the effective coverage area of the radio will be reduced. Positioning the antenna away from the body will also help the device meet the FCC’s RF exposure (SAR / MPE) requirements.

For best results, the antenna should be connected directly to the antenna cable. If you require an extension cable, it should be low loss, as short as possible, and have an impedance of 50 Ω. You must use a proper matching connector because each connector in the signal path introduces a return loss and reduces performance.

The following additional notes are provided courtesy of Larsen Antenna Technologies:

“There are a number of critical issues to consider when integrating antennas into portable RF systems. It is important to make allowances early in the design process to optimize performance and provide flexibility in antenna choice. Generally, it is prudent to position the antenna “up and away” from the radio modem and printer motors to

maximize noise reduction and receiver desensitivity. Other "high noise" areas to be avoided include displays and keypads that can seriously degrade antenna performance. Advances in antenna shielding techniques may also be incorporated to retain the integrity of the system.

"Mechanical issues for an integrated antenna revolve around proper cable routing and use of service loops to provide uninhibited antenna rotation if needed. The ability to position the antenna in a manner which will result in antenna deformation, impact resistance and aesthetic requirements must also be considered to design a workable form factor. The option to position the antenna vertically when in use so that performance is optimized is another consideration which can be limiting and a true consideration when choosing to use off-the-shelf solutions.

"Custom antenna solutions may be worthy of consideration for some projects. In some applications, custom designed antennas have shown performance increases of up to 2 dB when compared to quality off-the-shelf solutions. The cost of a custom design and resulting production can be as cost efficient as an off-the-shelf solution for projects requiring quantities as low as 20,000 antennas. "The use of state-of-the-art antenna theory, printed circuit technology, and application of evolving concepts can produce antennas with reduced sized without compromising performance.

"Examining the options available, and choosing an antenna early in the development process, can only benefit the performance and aesthetic appeal of a product. The engineering staff at Larsen Antenna Technologies are experts in this field with over 30 years of experience in helping OEMs reach their antenna design and production objectives."

Shielding

The electrical design of RIM radio modems provide high immunity to radio-frequency (RF) noise, also called electromagnetic interference (EMI). The metal casing also acts as a shield to help minimize the effect of RF interference originating from the computing device to which it is attached, and to prevent the RIM radio modem from emitting RF energy into the computing device and disrupting the computing device's operation.

Consequently, you do not need to provide any additional RF shielding between the RIM radio modem and a computing device, unless the environment contains an extreme level of RF noise (electromagnetic interference). In fact, it would be of greater benefit for the power supply to the radio modem to be free of high-frequency electrical noise, than to provide additional RF shielding.

The antenna must be positioned in such a way that the radiated energy is directed away from the computing device. If this positioning is not possible, then RF shielding may be required between the *antenna* and the computing device.

Note that circuits with a high impedance, and sensitive analog circuits, are especially vulnerable to nearby radio frequency emissions, and may need to be shielded. Typically-affected circuits include CRTs and LCD display drivers.

FCC radio frequency exposure rules

Based on FCC rules 2.1091 and 2.1093 and FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, OET Bulletin 65 and its Supplement C, all integrations of the RIM 902M OEM unit radio modems are subject to routine environmental evaluation for radio-frequency (RF) exposure prior to equipment authorization or use.

For portable devices, defined in accordance with FCC rules as transmitting devices designed to be used within 20 cm of the user body under normal operating conditions, RF evaluation must be based on Specific Absorption Rate (SAR) limits in W/kg. SAR is a measurement of the rate of energy absorption per unit mass of body tissue.

For mobile devices, defined as transmitting devices designed to be generally used such that a separation distance of at least 20 cm is maintained between the body of the user and the transmitting radiated structure, the human exposure to RF radiation can be evaluated in terms of Maximum Permissible Exposure (MPE) limits for field strength or power density in mW/cm^2.

Complying with FCC SAR/MPE guidelines

RIM has submitted module-specific information and test reports for a generic MPE compliance.

The antennas tested are:

- Larsen NMO 3E 900B (3 dBd gain)
- Andrew Eclipse Mag Mount (3 dBd gain)
- Austin 200160 500C (0 dBd gain)

The Larsen ground plane mount antenna, with a 6 foot cable length, passes the MPE test when it is 23 cm from the user. The passing distance for the Austin ground plane mount antenna and the Eclipse magmount antenna, with 6 foot cable, is 20 cm.

If the RIM 902M radio modem is integrated in a vehicle, and if one of the above antennas is used, the MPE limits will not be exceeded, provided that the antennas are installed at least 23 cm (Larsen) or 20 cm (Eclipse, Austin) from any edge of the vehicle rooftop. This can be accomplished by making it mandatory for customers to put a prominent warning in their user manual to tell the installer to make sure that the antenna is properly mounted in the centre of the vehicle rooftop. The user should also be warned to maintain the minimum required distance from the antenna.

Please note that the FCC grant for the RIM 902M does not limit or restrict it to operate in vehicle-mount configurations. As long as the antenna type, gain, loss, length (within 1” of those tested for MPE), minimum cable length of 6 feet, and minimum separation distance satisfy the MPE limits (through proper installation), and an appropriate warning statement is included in the user manuals of the final product, the FCC grant conditions are satisfied. For example, in a non-vehicle situation you may need to provide semi-fixed installation procedures for magmount antennas to ensure the MPE separation distances are met for satisfying grant conditions and to overcome mobility issues caused by such antennas.

Warning! If you use a different antenna, then your end product is not covered by RIM testing and submission; you must perform your own testing, submit for a separate FCC ID, and go through the appropriate process. It is mandatory for portable end products such as handheld and body-worn devices to comply with FCC RF radiation requirements with respect to the SAR limit.

Warning: If you use a different antenna, then your end product is not covered by RIM testing and submission, and you must perform your own testing, submit for a separate FCC ID, and go through the appropriate process. It is mandatory for portable end products such as handheld and body-worn devices to comply with FCC RF radiation requirements with respect to the SAR limit. The submission should include end product information, end product SAR / MPE test report, and a reference to the RIM module FCC ID for all other Part 90 requirements.

RIM strongly recommends the use of one of the following labs for SAR / MPE testing, because of their experience with this type of device testing using RIM radio modems.

For information on labs for SAR / MPE testing, visit the web site `http://www.rim.net/oem`.

During the SAR / MPE testing, the RIM testing software resides on an external PC that requires the ability to communicate with the radio modem directly. This requirement means that the device you submit for testing must have an external connector that can be used to connect the radio modem to a PC. If your device can run DOS programs, RIM can provide a DOS-based utility that joins two COM ports. This utility is useful if the radio modem might be connected to a handheld device's internal COM 4 port. There may also be an RS-232 serial connection COM 1 that is external to the device. It would be possible to make a virtual link between the two COM ports, so that an external device connected to COM 1 can communicate with the radio modem connected to the internal COM 4, eliminating the need to remove the radio from the handheld device.

Note Testing for FCC certification requires that the device transmit for much longer durations than it would during normal operation. SAR (specific absorption rate) testing generally requires a transmitter duty cycle of at least 25% for several minutes. To prevent the radio from resetting during testing, ensure that your power supply is able to maintain 4.1 volts or higher. Consult with the labs listed above to determine the most recent FCC requirements are for continuous transmission.

SAR and MPE limits

SAR limits for General Population / Uncontrolled exposure is 1.6 W / kg for partial body exposure, averaged over 1 g of tissue and 4 W / kg for hands, wrists and feet averaged over 10 g of tissue. The limits for Occupational / Controlled exposure are more relaxed, i.e., 8 W / kg for partial body and 20 W / kg for hands, wrists and feet. The 1.6 W / kg limit applies for most of RIM OEM integrators.

The limit for MPE is 0.6 mW / cm^2 at 900 MHz.

Guidelines

RF exposure distance is based on normal operating proximity to the user's or nearby persons' body. This distance is measured from any part of a radiating structure, which is generally the antenna, to the closest body part. If antennas other than those tested by RIM are used, a set of tests must be performed to determine the passing distance that meets the exposure limits with respect to SAR for handheld, body-worn, and portable devices, or MPE for vehicular and mobile devices.

Operating manual compliance statement

For mobile and vehicular devices, you should include a statement in your operation, user, and / or installation manual making the user aware of RF exposure issues and ensuring that the users keep a passing distance from the antenna while transmitting. You should provide instructions or diagrams in the manual for proper antenna mounting and position, when applicable, to ensure a safe exposure distance to the operator and nearby persons.

For handheld, body-worn, and portable devices, separate FCC approval is required to be in compliance with FCC RF exposure guidelines with respect to the SAR limits.

Label

Labeling is not required on the final device configuration provided that the separation distance is met for the antennas that have been tested by RIM to satisfy MPE requirements. Compliance with respect to SAR limits which satisfy MPE limits would not require warning labels, but an RF radiation warning label can be used to alert the user or nearby persons about abnormal usage conditions.

Installation instructions should, at a minimum, specify the correct mounting procedure on a ground plane, and recommend positioning the antenna so that the minimum distance is kept from any edge of the vehicle rooftop.

The following statement is an example of a warning that should be added to your user manual along with proper installation instructions. The following statement is written for the Larsen antenna, for which RIM has obtained FCC approval.

"Warning to integrators and users: To meet the FCC RF exposure requirement for mobile transmitter end products using the Larsen NMO 3E 900B, 3 dBd antenna, ensure that the antenna is at least 23 cm (11") away from the user or nearby persons when transmitting."

For more information

Sections 2.1091 and 2.1093 of the FCC Rules, which govern RF exposure limits, are available at:

`http://www.access.gpo.gov/nara/cfr/index.html`

Search for "47CFR2.1091" and "47CFR2.1093".

Bulletin 65 and its Supplement C, issued by the FCC RF Safety Group (Office of Engineering and Technology), is available at:

`http://www.fcc.gov/oet/info/documents/bulletins/#65`

You can obtain further information concerning FCC regulations, including RF exposure limits, by contacting the RF Safety Group:

Phone: (202) 418-2464
Email: rfsafety@fcc.gov
`http://www.fcc.gov/oet/rfsafety`

You can also contact the FCC Call Centre:
Phone: 1-888-CALL-FCC (1-888-225-5322)

You can contact the RIM engineering development team at:

Tel: (519) 888-7465
Email: oemsupport@rim.net

Specifications

The RIM 902M Radio Modem meets the following specifications.

Power supply & typical current usage

- Single power supply; operating range: 4.1 to 4.75 V DC
- Single 3.0 V logic line to turn on / off
- Maximum off current consumption: 20 µA
- Battery save stand-by mode: 0.2 mA (at 4.5 V)
- Receive / express stand-by mode: 54 mA (at 4.5 V)
- Transmit mode: up to 1.7 A (at 4.5 V, output 2.0 W)
- Average current draw (based on heavy usage of 5.00% receive, 0.05% transmit, 94.95% standby):
  if low-power standby mode is used: 3.7 mA (at 4.5 V)
  if low-power standby mode is not used: 8.8 mA (at 4.5 V)

RF properties

- Transmit frequency: 896 to 902 MHz
- 2.0 W nominal maximum transmit power at antenna port
- Transmitter can reduce output power by 15 dB (to 0.06W) when it is close to the base station, to balance radio link
- Receive frequency: 935 to 941 MHz
- Receiver sensitivity at 0.01 bit error rate (BER): -116 dBm
- 8000 bps 0.3 BT GMSK
- FCC Parts 15 and 90
- Industry Canada RSS 119

Serial communications

- 3.0 V asynchronous serial port
- Link speed: 9600 bps
- Link level protocols: RAP and MASC
- Parity: 7 bit with MASC or 8 bit RAP

Other features

- A firmware utility (MENU) to set the current network, send test messages to the radio modem, and monitor radio and network status.
- Software can activate radio
- Hardware flow control
- Radio parameters stored at power down
- Terminal devices may power-down while radio-modem remains operational
- Certified by Cingular Interactive to meet Mobitex Interface Specifications (MIS) including the following features:
- Personal subscriptions
- ESN verification

- Switching between different Mobitex networks
- Frame and continuous modes

Mechanical & environmental properties

- Weight: 35 g (1.2 oz), including case
- Footprint: 42.0 by 67.5 mm (1.65” x 2.66”)
- Thickness: 8.4 mm (.33”)
- 3.0V interface connector: 22 pin FPC (Flexible Printed Circuit) connector
- Antenna cable connector: MMCX
- Tested to IEC 68-2-6 Part 2 for vibration
- Metal case
- Operating temperature tested to: -30°C to +70°C
  (at 5-95% relative humidity, non-condensing)
- Storage temperature: -40°C to +85°C

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Glossary of terms

Term	Meaning
C	The speed of light. c = 3 x 10^8 m / s
dB	Decibel measures power based on a logarithmic scale. 10 dB = 10 times, 3 dB = 2 times, –10 dB = 0.1 times.
dBm	Decibel milliwatt measures signal strength based on a logarithmic scale. 0 dBm = 1 mW. –90 dBm = 1 pW.
dBμV	Decibel microvolt measures signal strength based on a logarithmic scale. 0 dBμV = 1 μV = -113 dBm.
FCC	**F**ederal **C**ommunications **C**ommission. The regulatory agency responsible for spectrum allocation in the United States.
FFC	**F**lat **F**lexible **C**able. The interface cable on the RIM radio modem is made using this type of flat multi-conductor wiring. Also known as FPC (Flexible Printed Circuit).
FPC	Flexible Printed Circuit. The interface cable on the RIM 902M is made using this type of flat multi-conductor wiring. Also known as FFC (Flat Flex Cable).
Gain	In this document, refers to increase / decrease in radiated power.
MAN	Mobitex Access Number. Each Mobitex radio modem has one unique MAN. A MAN is a 24-bit number. The network operator will assign a MAN to each radio modem when they authorize its use on their Mobitex network.
MASC	Mobitex Asynchronous Serial Communications. The link layer protocol exchanged via an asynchronous full-duplex serial channel between a data terminal or computing device and the RIM 902M OEM Radio Modem.
MMCX	The connector on the RIM 902M to which an antenna cable is connected.

Mobitex	A radio network and its communication protocols, created by Ericsson and the Swedish Telecommunications Administration.
MPAK	Mobitex Data Packet. A parcel of data transferred between the Mobitex network and the radio modem.
Network Operator	The corporation or agency which installs, maintains and authorizes use of a Mobitex network in a given area, usually within one country.
Noise	Refers to undesired, random interference combining with the signal. If the device is not immune to noise, the interference must be overcome with a stronger signal strength. Noise can be produced by electronic components.
OEM	Original Equipment Manufacturer. Usually implies that the “OEM product” is carried another manufacturer’s name. The RIM 902M is designed to be embedded in OEM terminals, PCs, and data gathering equipment.
OSI	The Open Systems Interconnection model allows different systems, following the applicable standards, to communicate openly with each another.
Polarity	Direction of current flow. Connecting some cables with the wrong polarity (i.e. backward) may damage the device.
Radio Modem	A device which provides modulation and demodulation for a radio frequency communications system.
Radiation	In this document, “radiation” refers to the emission of electromagnetic energy in the radio frequency (RF) band. Do not confuse this with radioactive particle emissions caused by nuclear reactions.
RAP	Radio Access Protocol. An alternative to the MASC protocol, found on the RIM 902M. Provides simpler implementation and faster, reliable operation.
Return Loss	A measure of antenna matching.
RF	Radio Frequency.
RS-232	The standard asynchronous serial communications interface used by most existing personal computers and mini-computers. Usually refers to both the communications protocol and the electrical interface.

RSSI	**R**eceived **S**ignal **S**trength **I**ndicator. A high RSSI represents a strong signal received by the radio modem from the base station.
SMA	An RF connector type.
TTL	Transistor-Transistor Logic. Used in digital circuits. Low (0) is represented by 0 V and High (1) by 5 V. The RIM 902M uses 3.0 V for High.
Type Approvals	These approvals are required by most governments before radio transmitters and equipment containing radio transmitters can be used. In the USA, a device must be tested and certified by an independent lab which is recognized by the FCC.
UART	Universal Asynchronous Receiver / Transmitter. Used as an interface between a microprocessor and a serial port.
VSWR	Voltage Standing Wave Ratio. A measure of antenna matching. See the Antenna Selection chapter.

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