*Integrator's
Guide*

RIM 902M

OEM Radio Modem

RIM

RIM 902M OEM Radio Modem Integrator's Guide
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Model No. R902M-2-O

Research In Motion

295 Phillip Street
Waterloo, Ontario
Canada N2L 3W8
tel. (519) 888-7465
fax (519) 888-7884

E-mail: rim902m@rim.net
Web site: www.rim.net

MOBITEX Interface, specified in Specification LZBA 703 1001, compatible equipment

FCC Compliance Statement (USA)

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.

Industry Canada Certification

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

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

About this guide

This document is a guide to integrating the RIM 902M OEM radio modem into a variety of devices such as laptop computers, handhelds, vending machines, point-of-sale terminals, vehicle-based mobile terminals, and alarm system.

Topics covered in this guide include:

- mounting requirements

- power (battery) characteristics

- interfacing to the RIM 902M

- antenna selection and placement

Throughout the guide, there are suggestions and precautions that will ease the implementation of a wireless communication solution. These recommendations are based on years of experience integrating wireless modems into a variety of devices. You are welcome and encouraged to contact RIM if you would like to discuss the technical implementation of this radio modem.

1

Introduction

With the introduction of the RIM 902M, Research In Motion (RIM) has set a new standard for radio modem performance. The RIM 902M is unrivaled in the key areas of receiver sensitivity, ouput 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 is designed for use with Mobitex wide-area wireless data networks operating in the 900 MHz range, such as the BellSouth Intelligent Wireless Network.

RIM radio modems are specifically designed to integrate easily into a computer or other embedded system. Potential applications include:

- Laptop computers
- Point of sale devices
- Ruggedized terminals
- Handheld PC's
- Parking meters
- Dispatching

- Vehicle tracking and location
- Monitoring and telemetry
- Vending machines
- Utility meters
- Billboards
- Security alarm panels

Radio performance

The RIM 902M offers the highest performance of any radio modem for Mobitex wireless data networks:

Receiver sensitivity

Receiver sensitivity is a measure of how well a radio modem can "hear" a network base station. This figure is important when a device will be 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.

The RIM 902M has a receiver sensitivity of –118 dBm, or 0.0016 picowatts. This is the strength of the weakest digital signal that can be interpreted with a 1% bit error rate. Although 1% may seem high, the sophisticated over-the-air Mobitex protocol corrects these errors *before* the 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.

Noise immunity

The RIM 902M is not de-sensitized 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 benefits, including:

- 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 can supply a full 2.0 watts to the antenna. However, the RIM 902M quickly decreases the output power when it is close to a base station – to as little as 0.06 watt – because a stronger signal is needed only when far from a base station. By transmitting a strong signal only when necessary, the RIM 902M conserves battery power.

The RIM 902M provides reliable transmit efficiency across the entire operating voltage range of 4.15 to 4.75 volts. As a result, batteries can be used even when nearing depletion. This also maximizes the radio coverage area throughout the life of the battery.

Low power requirements

If you are planning to integrate the RIM 902M into a handheld or portable device, battery life is a critical issue: your customers will insist on long lasting devices without heavy battery packs. The RIM 902M sets a new power consumption standard for Mobitex radio modems. This ensures efficiency and maximizes battery life.

Transmitting data: 1.7 amps or less (at 4.5V), 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: 60 mA (at 4.5V)

The radio turns its receiver ON for a 150 ms "window" once every 10 seconds. The base station will only attempt to communicate with the radio during this window. To minimize latency during rapid two-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: 0.3 mA (at 4.5V)

Standby power consumption 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 certain applications, such as in-vehicle applications that draw power from the vehicle battery. For these applications, it is possible to put the radio in an express operating mode, in which power consumption is higher than normal but packet transfer latency is reduced to a minimum.

Small size

Using a single board design, the RIM 902M is very thin, and much smaller than a business card, at only 42.0 by 67.5 mm. This tiny size allows the RIM 902M to meet tight space requirements within most applications. The fact that a single board is used means that the device is much more reliable than multi-board designs, particularly in high-vibration environments such as vehicles.

Mobitex network technology

The Mobitex wireless network technology, developed by Eritel in 1984 for Swedish Telecom, has become an international data communication standard. Now managed by the Mobitex Operators Association (MOA), which controls the specifications for this open standard, Mobitex 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 are therefore directly compatible with the RIM 902M OEM radio modem. Currently, Mobitex networks in other countries operate at other frequencies, such as 400 MHz.

Mobitex provides highly reliable, two-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 Mobitex network has a hierarchical structure that allows 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 common to the sender and the receiver. For example, one base station is able to handle all traffic in its coverage area.

The network constantly monitors the location of the mobile users. As a mobile 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 goes down 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. This 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. Conventional cellular phone systems, by contrast, use a circuit-switched network, in which a physical connection is created between the sending and receiving nodes, and must be maintained throughout the duration of the transmission. With circuit-switched systems, the set-up time for establishing a connection involves significant overhead and airtime cost, especially when only a small amount of data needs to be transferred.

Mobitex packets include information about the origin, destination, size, type, and sequence of data to be sent. This enables packets to be transmitted individually, in any order, as traffic permits. Internal to the network, individual packets may 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.

Set up time is eliminated and network connection is instantaneous. As a result, packet-switching makes far more efficient use of channel capacity, typically allowing 10 to 50 times more users over a radio channel than a circuit switched network.

FCC radio frequency exposure rules

Based on FCC rules 2.1091 and 2.1093[1] and FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, OET Bulletin 65 and its Supplement C[2], all integrations of the RIM 902M OEM unit are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use.

For portable devices, defined in accordance with FCC rules as a transmitting device 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 Watts/kg. SAR is a measurement of the rate of energy absorption per unit mass of body tissue.

For mobile devices, defined as a transmitting device 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 mWatts/cm^2.

RIM will submit module specific information and test reports for a generic MPE compliance. For an end product not covered by RIM testing and submission, the integrator will submit for a separate FCC ID. The submission should include end product information, end product SAR/MPE test report and a reference to RIM module FCC ID for all other Part 90 requirements.

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 body. This distance is measured from the feed point of the antenna to the closest body part. A test need to be performed to determine the passing distance that meets the exposure limits.

Operating manual compliance statement

The integrator should include a statement in their operation/user/installation manual making the user aware of RF exposure issues and insuring that the users keep a passing distance from the antenna while transmitting.

Also the integrator 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.

Label

If the final device configuration cannot be controlled so as to limit the user distance to the antenna then the device needs to have an RF radiation hazard label warning the user to keep away from the antenna by the specified distance.

2
Getting started

RIM is committed to facilitating the integration of the RIM 902M OEM radio modem. We provide the necessary resources to evaluate the feasibility of implementing a wireless communication solution, and work closely with our partners to develop an application in the shortest time possible.

Years of intense R&D have spawned several tools that have been used internally to help streamline our own development process. We have included many of these tools with the RIM 902M OEM Developer's Kit. The purpose of the Kit is to accelerate radio integration and to help system designers evaluate the RIM 902M. Using the Kit, you can quickly begin interfacing the radio modem to your computing device.

We're here for you!

RIM has a team of experienced engineers who can support you in the design and implementation of your project. If you need help getting started, or if you have any questions about the radio technology or its integration into your platform, please contact the RIM 902M engineering development team:

e-mail: **rim902m@rim.net**

phone: **+1 (519) 888-7465**

fax: **+1 (519) 888-7884**

web: **www.rim.net**

Test board overview

The RIM test board provides a standard RS-232 serial interface between a PC and the radio modem. It is designed to help you quickly interface the RIM 902M to a standard PC (through a COM port) or a terminal device with an RS-232 serial port. The test board also provides access points to the radio's serial communication port, which allows you to monitor activity with a logic probe, multimeter, or oscilloscope.

The test board includes the following components and functionality:

RS-232 interface

The serial (COM) port on a PC and most terminal devices operates at RS-232 signal levels, which are typically ±12V. This high voltage would damage the RIM 902M, which is typically integrated into a device that operates an asynchronous serial port at 3.0V. The RS-232 interface on the test board allows you to produce an output from the radio that is easily interpreted by a PC.

Test points

The test board is more than just an RS-232 interface. It also features debugging facilities to help you test your application. It provides direct access to each of the 22 pins on the serial data cable, which allows connectivity to analytical equipment (e.g. logic probe, multimeter, or oscilloscope) and real-time indication of data flow.

On/off switch

With the switch in the ON position, the radio will turn on whenever power is applied to the test board. When the switch is moved to the OFF position, the radio will shut down.

Power supply

The RIM 902M must be provided with a clean, high-current power source. In this case, we use 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.

How to connect the test board

Now that you are familiar with the components and functions of the test board, you are ready to connect the RIM 902M radio modem to an antenna and to a PC (or some other computing device with an RS-232 serial interface). To do this, you will use the test board and cables supplied with your RIM 902M Developer's Kit.

1. Flat serial cable (test board to radio)

The flat serial interface cable carries data between the test board and the RIM 902M. Control and status signals such as TURNON are also carried on this cable. Use this cable to connect the RIM 902M's serial connector to the test board.

This cable also carries clean, regulated power to the RIM 902M.

When inserting the cable, ensure that the side with the bare pins are in direct contact with the pin side of the connector.

2. DB-9 serial cable (test board to PC)

Connect the male end of the straight-through DB-9 serial cable to the test board.

Connect the female end of the cable to your PC's COM port.

3. Power adapter (test board to AC outlet)

Plug the 120VAC-to-12VDC power adapter into the wall outlet. Connect the other end to the power jack of the test board.

4. Antenna cable (radio to magmount antenna)

Your developer's kit includes a high-performance, 6dB-gain magmount antenna. This antenna is terminated with a screw-on SMA plug. The RIM 902M radio modem includes a snap-on MMCX jack. The antenna cable supplied with your developer's kit connects the antenna's SMA plug to the radio's MMCX jack.

The magmount antenna provides the best 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 (wall, furniture, equipment, etc.) between the antenna and the window. The antenna performs equally well if it is positioned upside down.

5. Turn the system on

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 ONI. It is lit when the radio is on.

The MENU diagnostics tool

Now that you have successfully connected your RIM 902M radio modem to your PC, you are ready to send a test packet through the Mobitex network.

Your radio modem should be activated by the network operator in order to be used on the Mobitex network and to establish an airtime agreement. If you have not already arranged for activation of your radio, contact your network operator.

The RIM 902M contains a diagnostic utility called MENU. With this utility, you can set the current network, "ping" your radio modem, or view radio and network status values.

Setup

The following instructions assume that your RIM 902M is connected to a PC running a terminal program, such as Windows HyperTerminal. The MENU utility is based in the RIM 902M's firmware, so HyperTerminal is the only software required to use it.

The MENU utility's user interface is a full-screen text mode interface, and uses the ANSI cursor command set. Programs like HyperTerminal support the ANSI codes by default. If you are using a different terminal program that does not provide ANSI cursor control, the MENU utility will drop into a line-by-line interface. The appearance of the line-by-line interface is not documented here, but the commands it uses are the same as those described below.

Select the COM port which communicates with the RIM 902M and configure for 9600 bps, and either 7E1 (7 bits, Even parity, 1 stop bit) or 8N1 (8 bits, No parity, 1 stop bit). If you have set this up correctly, you will see bursts of characters from the radio modem such as ^0010B 47E,0:5D. These character bursts are normal; the represent a MASC B frame, which you can ignore for now.

Type the word **menu** (all in lower case letters only) then press the ENTER key. You can expect to see a full screen of information. If nothing happens, simply re-enter **menu** until the radio modem responds. The word "menu" itself will probably not appear on the screen as you type it in.

If you re-enter **menu** and nothing occurs, ensure that the radio is turned on and connected to the PC, and that all cables are securely connected. Please contact RIM for assistance if you are stuck at this point.

Once the utility has been started, the terminal program's screen will look similar to the following:

```
RIM 902M Firmware Version 1.0.0

(c) 1999 Research In Motion Limited


Radio Setup                           Radio Serial Number = 031/11/066300

Command Key    Description                         Networks Available:
-----------    -----------                         -------------------
Q              Quit and reset the radio.           1. RMDUS (B433/B433)
                                                   2. CANTEL (C4D7/C4D7)
N              Set the current network.
P              Ping: Send a Status MPAK to yourself.




 Your Choice ?

MAN=16231144  RSSI= 40%  24 dBuV  Battery= 97%   Network=RMDUS   (B433/B433)
Contact=Yes   Mode=PowerSave  Live  Tx=Enabled   Active=Yes  Group List=Born
UpFreq=02FF  DoFreq=0F2F   Base/Area=14/0A   Status=0080
```

The screen displays the software version and build date, the radio modem's serial number, the list of available Mobitex radio networks, current radio modem status indicators, the "ping" function, and other relevant information.

RSSI stands for Received Signal Strength Indicator. This is a measure of network coverage. The higher the number, the better the coverage. The RSSI is given both as a percentage and in dBμV (decibel microvolts). To obtain the RSSI in dBm (decibel milliwatts), subtract 113 from the dBμV value. Note that RSSI= 0% 0 dBμV 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 dBμV or even less. Actual contact with the Mobitex network would be indicated by the **Contact** field. The RSSI is updated every ten seconds, or whenever you press D.

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

Network tells you which network you are currently using. The example shows RMDUS (BellSouth Wireless Data, formerly RAM Mobile Data, operates a Mobitex network in the United States) and CANTEL (Cantel AT&T operates a Mobitex network in Canada).

MAN stands for Mobitex Access Number, which is a unique number that identifies each Mobitex radio modem. The MAN is used for addressing packets. The screen will also display a **Radio Serial Number**, which is unique to each

radio modem. This number is often referred to in other documents as ESN (Electronic Serial Number) or MSN (Mobitex Serial Number).

Mode shows whether the radio is in powersave mode or express mode. The default operating mode is powersave, which reduces power consumption by the radio but introduces a latency of up to 10 seconds when receiving packets from the network. This mode may be changed through software.

Tx is an indicator to let you know whether the radio's transmitter is enabled or disabled. The transmitter may be enabled or disabled through software, 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, or not registered, or causing disruption to the Mobitex network. The word **Live** on the status line indicates that the radio is not in a DIE state.

A radio modem receives a **Group List** when it is powered up and registers with the network base station. Normally, you would see Group List=OK, 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 and **DoFreq** show the channels (in hexadecimal) that you are using to transmit and receive, respectively. 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 DoFreq=0F2F" then convert hexadecimal 02FF to decimal 767, divide by 80 and add to 890, and obtain 899.5875 MHz, which is the transmit channel. Add 39 MHz (or repeat the calculation using DoFreq) to determine that the receive channel at 938.5875 MHz.

Base/Area indicate 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 describes 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.

0000	The radio modem status is normal. There are no warnings.
0001	The RIM 902M has been out of 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 RIM 902M 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. Turning the radio modem off and back on will resolve this.
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 grouplist from the network. If this bit remains set after the modem has been in network coverage for several minutes, your radio modem is probably not activated. Contact the network operator to activate your device.
0100	Another device may be using the same MAN number 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 number.
0800	The RIM 902M may be having a problem remembering its last base station. If the problem persists, the unit should be returned for repair.
1000	The RIM 902M has received an unknown interrupt and might be having problems receiving packets. If the problem persists, the unit should be returned for repair.
2000	The RIM 902M has received an unknown interrupt. No action is necessary.
4000	The RIM 902M has been damaged and cannot be used until this problem is corrected. The unit should be returned for repair.

How to change to a different network

The RIM 902M radio may be used on different Mobitex networks operating on different channels in the 900 MHz range. Up to 16 network channel lists may be programmed by RIM into each radio. If the network shown is not the correct one, you can choose another from the list of networks available. Press N and the MENU utility will present an additional prompt for selecting the network, as shown below.

```
RIM 902M Firmware Version 1.0.0 release

(c) 1999 Research In Motion Limited


Radio Setup                              Radio Serial Number = 031/11/066300

Command Key    Description                       Networks Available:
-----------    -----------                       ------------------
Q              Quit and reset the radio.         1. RMDUS  (B433/B433)
                                                 2. CANTEL (C4D7/C4D7)
N              Set the current network.
P              Ping: Send a Status MPAK to yourself.




 Your Choice ? Choose a network from the list (1..2) ?

MAN=16231144  RSSI= 30%  22 dBuV  Battery= 97%   Network=RMDUS    (B433/B433)
Contact=Yes   Mode=PowerSave  Live  Tx=Enabled   Active=Yes  Group List=Born
UpFreq=02FF DoFreq=0F2F  Base/Area=14/0A  Status=0080

Change network name
```

You may now enter a number corresponding to the desired network shown under Networks Available. When you press Enter, the radio modem will switch to the selected network, as shown below. If you do not enter a number, or if you erase the number you have typed, then no change will occur when you press the Enter key. Pressing the Esc key will cancel the network set-up command.

The screen below shows what would happen if you typed in 2 and then pressed the Enter key. The values shown beside Network, UpFreq, DoFreq, and Base/Area are different.

```
RIM 902M Firmware Version 1.0.0

(c) 1999 Research In Motion Limited


Radio Setup                              Radio Serial Number = 031/11/066300

Command Key    Description                         Networks Available:
-----------    -----------                         -------------------
Q              Quit and reset the radio.           1. RMDUS  (B433/B433)
                                                   2. CANTEL (C4D7/C4D7)
N              Set the current network.
P              Ping: Send a Status MPAK to yourself.




 Your Choice ?

MAN=16231144  RSSI= 45%  25 dBuV  Battery= 97%   Network=CANTEL   (C4D7/C4D7)
Contact=Yes   Mode=Fallback   Live Tx=Enabled   Active=No   Group List=Born
UpFreq=030D DoFreq=0F3D  Base/Area=1B/09  Status=0080

Radio update was successful.
```

"Ping" the network: an end-to-end radio test

You can determine whether your radio modem is working on the network by pressing **P**. When you "ping," you send a message (MPAK – Mobitex data packet) to yourself via the wireless network base station. The MENU utility will display a message indicating that the MPAK was sent. A few seconds later, it should also indicate that the MPAK was received. This confirms that your radio modem is operational and active on the network.

If you get the message "Status MPAK cannot be sent – out of coverage", then you are not in an area that is covered by the Mobitex network. You can determine whether you are in coverage by looking at **Contact** on the status lines. If you are certain that you are in a coverage area, but are still not able to communicate with the network, check the antenna to make sure it is connected properly and is deployed properly. Signal quality can vary significantly within a building. Try moving the antenna to a new location, perhaps near a window, to see if you can get a signal.

If you get the message indicating that the Status MPAK was sent, but you did not get one that it was received, then you are in coverage but your RIM 902M radio modem has probably not been activated by your network operator, and the network will not send the MPAK back to the radio. Contact the network operator to activate your design.

```
RIM 902M Firmware Version 1.0.0

(c) 1999 Research In Motion Limited


Radio Setup                               Radio Serial Number = 031/11/066383

Command Key    Description                         Networks Available:
-----------    -----------                         -------------------
Q              Quit and reset the radio.           1. RMDUS (B433/B433)
                                                   2. CANTEL (C4D7/C4D7)
N              Set the current network.
P              Ping: Send a Status MPAK to yourself.



 Your Choice ?

MAN=16231227  RSSI= 11%  14 dBuV  Battery=100%   Network=RMDUS   (B433/B433)
Contact=Yes   Mode=PowerSave  Live  Tx=Enabled   Active=Yes  Group List=Born
UpFreq=02FF  DoFreq=0F2F  Base/Area=14/0A  Status=0080

Received MPAK from 16231227 (to 16231227) Type=03(STATUS  )  Traffic/Flags=00
```

If you are unable to communicate with the network, then contact the network operator to make sure 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. Second, make sure that you are in network coverage. You can determine whether you are in coverage by looking at **Contact** on the status lines. If it shows Contact=NO, then you are not in an area that is covered by your Mobitex network. You can also determine whether the antenna is connected properly and is deployed properly. Signal quality in buildings can vary significantly over short distances. Try moving the antenna to a new location, perhaps near a window, to see if you can get a signal. If none of these remedies help, contact RIM for assistance.

Exiting the utility

When you have finished using the utility, you should press Q to quit. This step is important because it allows the radio to resume accepting commands from other software. The screen will clear and you will be informed that the radio has been reset. You can safely disconnect the radio and close your terminal program once you have seen this message.

3

Mechanical integration

This chapter provides information about the RIM 902M that will be useful in determining the physical positioning of the radio modem within an application. Environmental properties and testing, physical properties, mounting methods, and connector information are presented.

Environmental properties

During environmental testing, RIM takes samples of its radio modems and subjects them to a variety of harsh conditions. We measure over a hundred digital RF calibration parameters, once before and once after each test. The difference between these measurements precisely reveal any performance degradation. Each unit in the sample is also inspected visually after testing. This experience allows us to fine-tune our design and manufacturing process.

Environmental testing ensures that our products are able to withstand both typical and extreme real-world conditions in which they will be used. RIM does not sell units that have been subject to environmental testing.

Storage temperature

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

Operating temperature

The RIM 902M is designed to operate between -30°C to +70°C (-22°F to +168°F).

The end user should be careful not to exceed the upper temperature limit of +70°C, as performance degradation or damage to the power amplifier may occur past this point, especially when packets are transmitted frequently.

Physical properties

Weight

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

Dimensions

The RIM 902M has been designed to meet the most stringent space requirements. In most cases, there will be sufficient room in an existing enclosure to house the radio modem.

The overall maximum dimensions of the radio modem, not including cables, are:

- Width: 42.0 mm

- Length: 67.5 mm

- Thickness: 8.4 mm

Ø2.5±0.1(4X)

⊕ | Ø0.1 | X | Y | Z

36.5

2.75

-Y-

22 PIN ZIF CONNECTOR
(1mm SPACING)

8.4±0.36

22-----------1

62.5

67.5

-Z-

42

2.75

8±0.36

-X-

5.5±0.3

-Y-

-X-

22.6

MMCX RF CONNECTOR

DIMENSIONS ARE IN: mm

UNLESS OTHERWISE SPECIFIED
TOLERANCES ARE:
    LINEAR: ± 0.2
    ANGULAR: ± 1°

INTERPRET DIMENSIONS
AND TOLERANCES AS PER
ANSI Y14.5M-1994

MOUNTING HOLE PATTERN: 4 HOLES IN A 62.5x36.5mm RECTANGLE.

RIM 902M OEM Radio Modem – Integrator's Guide

Mounting methods

The RIM 902M OEM radio modem may be securely fastened using a variety of methods. The operating environment must be carefully cons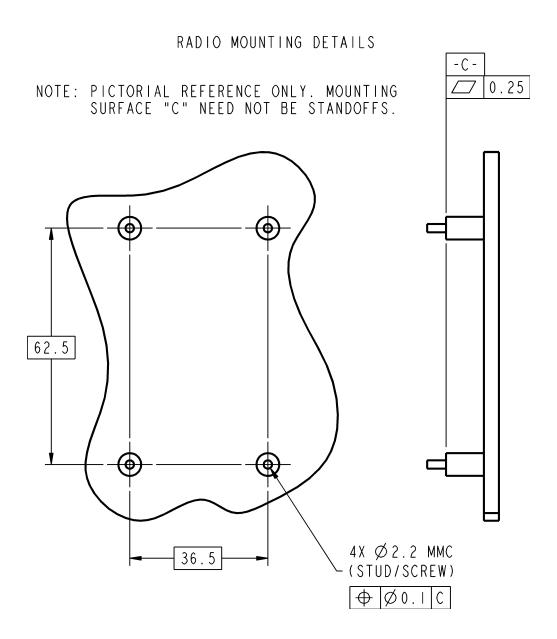idered when choosing a mounting option. For example, extreme temperature or heavy vibration may require a special mounting solution. It is important to ensure that the RIM 902M remains securely attached in the environment where it will be used.

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

Bolts

The RIM 902M radio modem includes a hole in each corner, which may be used to bolt the device onto a circuit board, device housing, 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.

The following diagram illustrates the radio mounting details.

RADIO MOUNTING DETAILS

NOTE: PICTORIAL REFERENCE ONLY. MOUNTING
SURFACE "C" NEED NOT BE STANDOFFS.

-C-

⌗ | 0.25

62.5

36.5

4X ⌀2.2 MMC
(STUD/SCREW)

⊕ | ⌀0.1 | C

Tie wraps

Tie wraps can be used to as a secure but non-permanent means of attaching the
RIM 902M to a surface. Typically, each tie wrap passes through a hole drilled

RIM 902M OEM Radio Modem – Integrator's Guide

into the surface on either side of the RIM 902M. This allows the radio to be attached to a shell, a PCB, or some other mounting surface.

If using tie wraps, ensure that the surface beneath the RIM 902M is flat. Otherwise, the mounting surface could push up on the bottom surface of the radio case while tightening the tie wraps pushes down on the edge of the radio case. This could cause the metal case of the RIM 902M to flex upward and short across components inside the radio, causing the radio to malfunction. For example, thick adhesive foam tape and tie wraps should not be used together.

Permanent industrial adhesive

The RIM 902M is 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 bolts to loosening. In many cases, an effective solution is to adhere the radio modem to the inside surface of your product's casing.

An adhesive should be chosen on the basis of its ability to stick to the material used in the outer casing of the radio modem and in the surface to which the radio will be mounted. The bottom casing of the RIM 902M 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 will not need to be removed. Choose foam tape for rough surfaces and adhesive tape for smooth surfaces.

More information about VHB may 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.
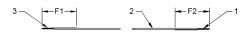
Cables and connectors

There are two connectors on the RIM 902M radio modem. These connectors allow interfacing from the radio modem to a serial computing device, a power supply, and an antenna.
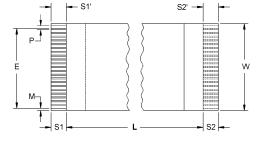
Serial cable and connector

The RIM 902M serial communication and control signals are carried on a flat 22-conductor 0.30 mm (0.012") thick flexible printed circuit (FPC) cable in 1.00 mm centerline spacing, which can plug into a matching connector. Since each application is unique, Molex can create a custom Flat Flex Cable Jumper in the correct length and the correct connector orientation for your application. The minimum cable length available is 30 mm (1.181").

The serial cable supplied with the RIM 902M Developer's Kit is a Type D 4" long Flat Flex Cable Jumper in 1.00 mm centerline spacing, as illustrated in the following mechanical drawing:

DEFINITION FCC TYPE D:

THE MOLEX PART NUMBER OF THIS CABLE IS 8800-8071.

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. A variety of connectors are manufactured by Molex. More information about each connector, including mechanical drawings, is available from the manufacturer's web site (www.molex.com), or you can contact RIM (rim902m@rim.net) for help with selecting an appropriate connector for your application.

Contact:

Molex Headquarters	Molex Electronics Ltd.
Lisle, IL, USA	Toronto, Ontario, Canada
tel: (630) 969-4550	tel: (416) 292-1444
fax: (630) 969-1352	fax: (416) 292-2922
www.molex.com	

Antenna cable and connectors

RIM selected the industry-standard MMCX connector for the RIM 902M because it is a very small connector that has the mating force to withstand heavy vibration.

Typically, an antenna does not plug directly into a RIM 902M. Instead, an

connector at the outer casing of the device. This allows the antenna to be removed from the system without having to open 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's MMCX plug. The other end of the cable can be any connector you choose, as long as it has 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 RIM 902M developer'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 can provide antenna cables and connectors. The parts described below have an impedance of 50 Ω and are suitable for use with the RIM 902M.
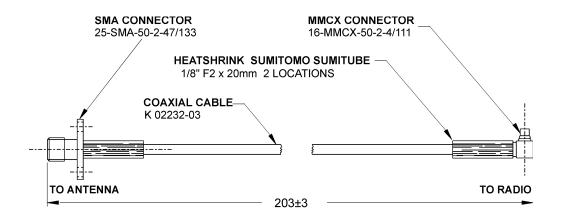
11MMCX-50-2-1C/111	Straight MMCX connector
16MMCX-50-2-1C/111	Right-angle MMCX connector
25SMA-50-2-25/111	SMA connector
EZ Flex 405	Low-loss matching (50 Ω) cable
133REEZ4-12-S2/1216	8" cable, straight MMCX to SMA
133REEZ4-12-S2/1699	8" cable, right-angle MMCX to SMA

SMA CONNECTOR
25-SMA-50-2-47/133

MMCX CONNECTOR
16-MMCX-50-2-4/111

HEATSHRINK SUMITOMO SUMITUBE
1/8" F2 x 20mm 2 LOCATIONS

COAXIAL CABLE
K 02232-03

TO ANTENNA

TO RADIO

203±3

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

The following cable is included with the RIM 902M Developer's Kit:

Contact:

Huber & Suhner
Essex Junction, VT, USA
tel: (802) 878-0555
fax: (802) 878-9880
www.hubersuhnerinc.com

Huber & Suhner
Kanata, Ontario, Canada
tel: (800) 627-2212
fax: (613) 596-3001

3

Power requirements

The RIM 902M radio modem must be provided with a clean power source capable of delivering bursts of high current. This can be provided by a plug-in power supply unit, a rechargeable battery pack, or single use batteries. RIM has conducted extensive research and has developed guidelines for integrators to follow when designing the power supply system for the RIM 902M.

Load specifications

The RIM 902M draws its power in bursts; the power required changes rapidly depending on whether the radio is transmitting, receiving, or in standby. The load profile is given on the following page. These specifications can be given directly to your power supply designer or battery supplier.

Power supply parameters

The RIM 902M requires a clean, stable 4.15 to 4.75 volt source that is capable of delivering a one-second burst of up to 1.7A when required by the transmitter. Under non-ideal conditions such as an improperly matched antenna, however, this burst could be as high as 2.2A. The receiver current consumption is 66 mA and the standby current consumption is 0.07 to 0.2 mA. The maximum no-load

Radio load profile (at 4.5V)

Transmitter ON	
at 2.00 W to antenna	1.7 A
worst-case peak instantaneous (due to extreme temperature, poorly matched antenna, etc.)	2.2 A
Receiver ON	57 mA
In EXPRESS mode, the receiver is always ON. In POWERSAVE mode, the receiver is typically ON for 0.15 s then OFF for 9.85 s	
Standby (transmitter and receiver are both OFF)	0.2 mA
Standby mode occurs for 9.85 s out of 10 s if in POWERSAVE mode and no activity has taken place for previous 10 s	to 5.4 mA
Typical average power-save current consumption	
transmit 0.17%, receive 9.74%, standby 90.09%	5.7 mA
transmit 1%, receive 5%, standby 94%	20.0 mA
Transmit duration	
minimum	32 ms
maximum	1 s
Off current consumption	$\leq$ 20 μA

Batteries

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

Rechargeable batteries

We recommend using rechargeable nickel cadmium (NiCad) batteries to power vthe RIM 902M radio modem for battery-operated applications that require a wide operating temperature range. Nickel metal hydride (NiMH) and Lithium ion (Li+) cells may 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 can help you determine whether a particular battery is suitable for your application.

The cells chosen must be able to meet the load specifications of the RIM 902M. Specifically, they must be able to provide 1.7 A (at 4.5V) for transmission. Rechargeable cells vary considerably, because capacity varies with current draw. Even if two cells have the same published capacity, one may 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 transmit 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 get 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 also not intended to be used to their full capacity, so the actual useful run-time 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, alkaline AA's 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 not recommended, as this type of battery is unable to supply the power required by the transmitter. If this type of battery is used, the voltage will drop below the minimum power required under load almost immediately following a radio transmit, which would reset the radio.

Since carbon cells are generally sold under names like "super heavy duty," the best way to be sure that a single-use battery is alkaline is to look for the word

"alkaline" on the label, or to use well-known brands such as Duracell or Energizer. This should be communicated to the user of your product.

Plug-in supplies

A plug-in supply converts normal AC power (usually 110 volts or 220 volts) into a steady DC source that can be used instead of batteries. The plug-in supply must be designed to ensure voltage spikes, lightning, and other power fluctuations cannot damage the radio modem. Transient voltage protection zener diodes, or other spike arrestor circuits, may be added to keep the inputs within the limits given in the RIM 902M load specifications. These should have a value of 20 volts and be placed on the supply side of the regulator circuit.

RIM recommends a supply capable of providing 4.5 V and rated for 2.5 A peak current.

Automotive supplies

If you plan to power the RIM 902M from an automotive supply, extra protection must be included to protect the radio modem from the intense power fluctuations experienced when the automobile is started. A circuit comprising inductors, transorbs and voltage regulators should be used to ensure 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 during starting. Commercial automotive adapters are available that will safely convert the 12 volt automotive supply to a regulated supply suitable for operating the RIM 902M radio modem.

4

Interface specification

The asynchronous serial interface on the RIM 902M operates at 3.0V. It is similar to RS-232 except that 0V represents a "low" and 3V represents a "high." This interface can be connected directly to a micro-controller, or through a UART to a microprocessor data bus.

MASC and RAP link-layer protocols

The RIM 902M requires a serial link-layer protocol to carry data, radio control instructions, and radio status information between the RIM 902M radio modem and the computing device to which it is attached. Two protocols are supported: Mobitex Asynchronous Communication (MASC) and 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 – simply continue using the MASC application. If you are writing a new application for the RIM 902M, you will need to 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

is designed to be extremely robust and redundant, and should be used when the serial link is unreliable or when the serial cable to the RIM 902M is very long.

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 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 to 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 double 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.

	MASC	**RAP**
Serial cable between RIM 902M and 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 API's	Days
Memory requirements	10 to 50 kilobytes	1 to 3 kilobytes
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 API's	Free, open specification, sample source code is free

There is no "best" protocol. The MASC or RAP protocol is used strictly for the link between the radio modem and the computing device, and does not have any influence on the speed or reliability of communication between the radio and the Mobitex network. The RIM engineering development team (e-mail: rim900@rim.net) can help you select the protocol most suited to your needs.

Pin descriptions

All input and output lines are 3.0 volt logic; however, they will also be able to drive 3.3 volt systems. Further, all input lines to the serial port are 5.0 volt tolerant and outputs will be capable of driving 5.0 volt systems provided the V_{IH} of these pins is less than 2.5 volts. Pins 1 through 4, the general purpose I/O lines, are strictly a 3.0 volt interface; they are not 5.0 volt tolerant.

This section describes the purpose of each of the 22 lines that comprise the serial interface of the RIM 900 OEM radio modem. The symbol ~ before the label indicates that line is an active low digital signal.

Pins 1, 2, 3, 4, 13, and 22 are designed for future use and must be left disconnected. All other unused inputs to the radio should be tied to ground, and any unused outputs from the radio should be left disconnected.

Pin 5   ~MSG   ~Message Waiting

This is an output from the radio.

The active state of this line is low, and indicates that the radio has received a message (packet) from the network, which has not been delivered to the device application yet. This line continues to remain active until the application acknowledges receiving the packet.

When the radio's receive buffer is full, this line will be inactive (high).

Pin 6   ~COV   ~Coverage

This is an output from the radio.

The active state of this line is low, and indicates that the radio is in network coverage, as measured by the presence of a signal from the network base station.

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

Pin 9   GND   Ground

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

Pin 10   TURNON   Turn Radio On

This is an input to the radio.

This line turns on the radio unit. It is a digital signal that eliminates the need for an on/off switch across the power supply to the radio. Information about the use of this pin is contained in the next section of this chapter.

Pin 11   ONI   On Indicate

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

This line may 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 is not ready to receive data because it is off.

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

Pin 12   TRI   Transmit Indicate

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

This output from the radio that is asserted while the RIM 900 is transmitting a packet to the network base station. TRI can be used to provide real-time visual feedback to the user that the radio is transmitting packets. If this is not necessary, the line can simply be left disconnected.

This line is low when the Radio is off.

Pin 14   ~RI   ~Ring Indicate

This is an output from the radio.

When ~DTR is not asserted (high), the RIM 900 asserts ~RI (low) to indicate that it has data waiting for the computing device. The radio will not transfer the data until ~DTR is asserted (low). This line can be used to wake up a suspended computing device when the radio needs to communicate with it. If ~DTR is already asserted (low) when the radio has data to send the computing device, ~RI will not be asserted.

For MASC implementations in normal serial mode, this line indicates that the radio has any MASC frame to transfer to the computing device. For MASC implementations in interactive serial mode, this line indicates that the radio has received an MPAK from the Mobitex network, and has a MASC M frame containing the MPAK to transfer to the computing device.

For RAP implementations, ~RI is not used and should not be connected. This line should also be disconnected if your application does not use it.

Pin 15   ~CTS   ~Clear To Send

This line is an output from the radio modem. The active (clear to send) state of this line is low.

All MASC implementations require this line. This line is optional for RAP implementations. To use hardware flow control with RAP, the radio must be in interactive serial mode (see pin 10). Do not connect ~CTS if your application does not require it.

This is an output from the RIM 900 to the computing device. This line is asserted low by the RIM 900 to indicate that it is ready to receive data from the computing device. When this line is high, any data sent from the computing device to the RIM 900 may be lost. This is a flow control mechanism that is normally reacted to by the UART in your serial communication system.

When the radio is turned off, this line will be low from inside the radio modem with an impedance of at least 20 kΩ.

Pin 16   ~RTS   ~Request To Send

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

All MASC implementations require this line. This line is optional for RAP implementations. Connect ~RTS to ground if your application does not require it.

This is an input to the RIM 900 from the computing device. This line should be asserted low by the computing device to indicate that it is ready to receive data from the RIM 900. This is a flow control mechanism that is normally handled by the UART in your serial communication system.

Pin 17   ~DSR   ~Data Set Ready

This line is an output from the radio.

The active (data set ready) state of this line is low.

When the RIM 900 is off, this line will be low from inside the radio modem with an impedance of at least 20 kΩ.output from the RIM 900 that indicates the state of DTR.

Pin 18   GND   Ground

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

Pin 19　~DTR　　　　　　　　　　　~Data Terminal Ready

This line is an input to the radio.

The active (data terminal ready) state of this line is low, and indicates that the computing device is ready to receive data from the RIM 900. De-asserting this line high will turn communication off; the RIM 900 would 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 will allow communication to resume.

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

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

Pin 20　TX　　　　　　　　　　　　　　　　Transmit

This line is an input to the radio. Its idle (no data) state is high.

This is an asynchronous serial input to the radio unit, 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 is an output from the radio. Its idle (no data) state is high.

This line is an asynchronous serial output from the radio unit, 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.

How to turn the radio on and off

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

Turning the radio on

To turn the RIM 902M 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 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 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 fails to respond to a high TURNON line, the radio may require service, or the power supplied to the radio may be too low for proper operation.

Turning the radio OFF

To turn the RIM 902M off, your software should de-assert the TURNON line by setting it low. The radio will then begin shutdown operations, and the ONI pin will remain active until all shutdown operations are complete.

Shutdown will normally require several seconds to complete, and the radio should not be disturbed while it is shutting down. Attempting to communicate with the radio 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 serial inputs to the radio should be low when the radio is turned off. This ensures that 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.

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

A controlled shutdown is necessary to allow the RIM 902M to tell the Mobitex network that it is off air.

Interface to an RS-232 device

The RIM 902M serial interface operates at 3.0V, making it compatible with many existing system designs. In most cases, the RIM 902M can be connected directly to a micro-controller without any additional interface logic. If the radio modem is to be connected directly to a PC or other RS-232 device, an interface must be provided.

Interface to microprocessor

The RIM 902M can be controlled by a wide variety of microcontrollers and microprocessors, such as the Intel 8051 or 80386, or Motorola 68000.

A standard 8250 Universal Asynchronous Receiver/Transmitter (UART) interface may be used as the means for communicating with the microprocessor's data bus.

5

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 902M.

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 RF systems operating in the 900 MHz 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 902M 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 reflects electromagnetic radiation that would otherwise be lost to the antenna. This

effectively doubling 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 902M.

Impedance:	50 Ω
Center frequency:	913.5 MHz, ±5 MHz (λ=32.8 cm, ±0.2 cm) *this is deliberately biased toward transmit in order to help balance the two-way link between the radio modem and the network base station*
Frequencies of operation:	896 to 902M MHz (transmit) 935 to 941 MHz (receive)
Acceptable return loss:	VSWR < 2.0 or RL < −10 dB (minimum) VSWR < 1.5 or RL < −14 dB (recommended) *required across all frequencies of operation*

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 an ideal *isotropic radiator*, expressed in decibels (dB) of power gain.

An isotropic radiator a 100% efficient point source radiator with a spherical radiation pattern. Its field energy density is identical in any direction from the radiator at each fixed distance from the radiator. An isotropic radiator cannot exist in practice; it is an unrealisable theoretical reference for measuring antenna gain and radiation patterns.

The power output of the RIM 902M is 62 mW to 2.0 W at the antenna port, and the antenna gain (or loss) will result in an increase (or decrease) in this value. The actual output is called the Effective Radiated Power, or ERP. For example, if the RIM 902M is putting out 2.0 W of power to a 2.3 dB gain antenna, the ERP is $2.0 \times 10^{(2.3 \div 10)} = 3.4$ 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 is 50 Ω, which is a widely-available industry standard. Any deviation from this value may result in impedance mismatch.

Impedance mismatch can 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 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 RIM 902M) to reflected power (into the RIM 902M).

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

Equation 2: VSWR

VSWR = 1 or RL = −∞ dB is a perfect match. In practice, there will always be imperfections, 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 902M MHz (transmit) and 935 to 941 MHz (receive). The 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

The optimal antenna radiation efficiency is produced by an antenna measuring one wavelength, λ. The value of λ for the RIM 902M 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'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.

Positioning the antenna

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 ideally be oriented so that it provides vertical polarization. This is achieved by positioning the antenna vertically upward when the RIM 902M 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, as it would reduce 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 RF reflections whenever the device is placed on a metal surface.

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.

For best results, the antenna should be connected directly to the antenna cable. If an extension cable is required, it should be low loss, as short as possible, and have an impedance of 50 Ω. It is important that a proper matching connector be used, as each connector in the signal path introduces a return loss and reduces performance.

Shielding

The electrical design of the RIM 902M provides high immunity to RF noise. 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 902M 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 902M and a computing device. In fact, it would be more important for the power supply to the RIM 902M 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 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.

Specifications

The following is a summary of the RIM 902M OEM radio modem specifications.

Power supply & typical current usage

- Single power supply; operating range: 4.1 to 4.75V DC
- Single 3.0V logic line to turn on/off
- Typical off current consumption: less than 10μA
- Battery save stand-by mode: 0.2 mA (at 4.5V)
- Receive / express stand-by mode: 57 mA (at 4.5V)
- Transmit mode: up to 1.7A (at 4.5V, output 2.0W)
- Average current usage: 20 mA (at 4.5V, based upon 94% standby, 5% receive, 1% transmit)

RF properties

- Transmit frequency: 896 to 902M MHz
- 2.0 W nominal maximum transmit power at antenna port
- Transmitter can reduce output power to 0.06 Watts (-15 dB) when it is close to the base station, to balance radio link
- Receive frequency: 935 to 941 MHz
- Receive sensitivity: -118 dBm at 0.01 bit error rate (BER)
- 8000 bps 0.3 BT GMSK
- FCC Parts 15 & 90
- Industry Canada RSS 122

Serial communications

- 3.0V asynchronous serial port
- 7 bit with parity (MASC) or 8 with no parity (RAP)
- Link speed: 9600 bps
- Link level protocols:
  - Radio Access Protocol (RAP)
  - Mobitex Asynchronous Communication (MASC)

Other features

- A simple-to-use firmware utility displays serial number, MAN, RSSI level, battery strength, and network parameters. It can also select different Mobitex networks or "ping" the network to test the radio modem.
- 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 RAM Mobile Data 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: 1.2 oz (35 g), including case
- Footprint: 42 by 69.5 mm
- Thickness: 8.4 mm
- 3.0V serial connector: 22 pin FPC (Flexible Printed Circuit) connector
- Antenna cable connector: MMCX
- Tested to IEC 68-2-6 Part 2 for vibration
- Metal case, available in a variety of materials
- Operating temperature tested to: -30°C to +70°C
  (at 5-95% relative humidity, non-condensing)
- Storage temperature: -40°C to +85°C

Glossary of terms

Term:	Meaning:
c	The speed of light.
dB	decibel. A measure of power, based on a logarithmic scale.
Embedded System	A computer without the normal display, keyboard, and disk drives of a PC.
FPC	**F**lexible **P**rinted **C**ircuit. The serial communication cable on the RIM 902M is made using this type of flat multi-conductor wiring.
Gain	In this document, refers to increase/decrease in radiated power.
MAN	**M**obitex **A**ccess **N**umber. 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	**M**obitex **A**synchronous **S**erial **C**ommunications. 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	**M**obitex Data **Pack**et. A parcel of data transferred between the Mobitex network and the radio modem.
Network Operator	The corporation or agency which installs, maintains and authorises 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.

Term:	Meaning:
OEM	**O**riginal **E**quipment **M**anufacturer. Usually implies that the "OEM product" is re-labelled with another manufacturer's name. The RIM 902M is designed to be embedded in OEM terminals, PCs and data gathering equipment, and as such the equipment it is embedded in will not normally carry RIM's name.
OSI	The **O**pen **S**ystems **I**nterconnection 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 **mo**dulation and **dem**odulation 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	**R**adio **A**ccess **P**rotocol. 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	**R**adio **F**requency.
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.
SMA	An RF connector type.
TTL	**T**ransistor-**T**ransistor **L**ogic. Used in digital circuits. Low (0) is represented by ~0 V and High (1) is ~5 V.
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	**U**niversal **A**synchronous **R**eceiver/**T**ransmitter. Used as an interface between a microprocessor and a serial port.
VSWR	**V**oltage **S**tanding **W**ave **R**atio. A measure of antenna matching. See **Chapter 5, Antenna Integration**.

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