Integrator's
Guide

RIM 802D

OEM Radio Modem

DRAFT

RIM 802D OEM Radio Modem Integrator's Guide
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Model No. R802D-2-O

Research In Motion

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DRAFT *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.

DRAFT *Industry Canada Certification*

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

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 guide will assist you in integrating the RIM 802D 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 802D

- antenna selection and placement

Throughout the guide, there are suggestions and precautions that will ease the implementation of a wireless communication solution. You are 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 802D, Research In Motion (RIM) has set a new standard for radio modem performance. The RIM 802D is unrivaled in the key areas of 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 802D is designed for use with DataTAC wide-area wireless data networks operating in the 800 MHz range, such as the American Mobile ARDIS network and the Bell Mobility ARDIS network.

RIM radio modems are specifically designed to integrate easily into a computing device. 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 802D offers the highest performance of any radio modem for DataTAC 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 802D has a receiver sensitivity of –118 dBm (MDC) and –111dBm (RD-Lap) at 0.01 BER. This means that the radio can interpret received data from a very weak 0.0025 picowatt signal with a 1% bit error rate. Although 1% may seem like a high error rate, the sophisticated over-the-air DataTAC 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 802D 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 key benefits, including:

- easier integration
- longer battery life
- increased reliability

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

Low power requirements

If you are planning to integrate the RIM 802D 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 802D sets a new power consumption standard for DataTAC radio modems. This ensures efficiency and maximizes battery life.

Transmitting data: 1.7 amps or less (at 4.4 V), depending on output power

The transmitter is ON for a pulse of up to 1.1 seconds, depending on the amount of data transmitted. The maximum packet size for a DataTAC device is 2048 bytes.

Receiving data: 66 mA (at 4.4 V)

The radio's receiver is usually turned off, and turned on periodically for the purpose of listening to the network for messages. The base station will only attempt to communicate with the radio during these windows. 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: 0.2 mA (at 4.4 V)

Standby power consumption is very low and occurs when no radio activity has taken place for at least 10 seconds and the radio is not in a receiver-on window. 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 802D is very thin, and much smaller than a business card, at only 42.0 by 67.5 mm. This tiny size allows the RIM 802D 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 PCs).

DataTAC network technology

The DataTAC wireless network technology has become an international data communication standard. DataTAC is a secure, reliable, wireless packet switching network specifically designed for wide-area wireless data communications.

DataTAC networks are deployed around the world. DataTAC 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 DataTAC 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 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 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.

DataTAC 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.

DataTAC 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.

2
Getting started

RIM is committed to facilitating the integration of the RIM 802D 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 802D OEM Developer's Kit. The purpose of the Kit is to accelerate radio integration and to help system designers evaluate the RIM 802D. 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 802D engineering development team:

e-mail: **rim802d@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 802D 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 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 802D, 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 radio interface 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 802D 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 802D 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 802D Developer's Kit.

1. Flat interface cable (test board to radio)

The flat interface cable carries data between the test board and the RIM 802D. Control and status signals such as TURNON are also carried on this cable. Use this cable to connect the RIM 802D to the test board.

This cable also carries clean, regulated power to the RIM 802D.

When inserting the cable, ensure that the side with the bare pins are in direct contact with the pin side of the connector. To ensure proper contact, do not force the cable into the connector. Instead, pull the tabs on either side of the connector, slide the cable in, then push the tabs back in to tighten.

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 5VDC, 2.4A, center-pin-positive 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 802D 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 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 (wall, furniture, equipment, etc.) between the antenna and the window. The antenna must be oriented vertically for best performance, and performs equally well whether positioned rightside up or upside down.

5. Turn the system on

The power switch on the test board is connected to the TURNON line of the RIM 802D 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 802D radio modem to your PC, you are ready to send a test packet through the DataTAC network.

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

The RIM 802D 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 802D is connected to a PC running a terminal program, such as Windows HyperTerminal. The MENU utility is based in the RIM 802D'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 802D 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 may see occasional bursts of characters from the radio modem. These character bursts are normal; they represent an NCL 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 802D 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. AMSC
                                                  2. BELLMOB
N              Set the current network.
P              Ping: Send a Status SDU to yourself.




 Your Choice ?

LLI=88231144  RSSI= 40%  24 dBuV  Battery= 97%    Network=AMSC
Contact=Yes   Mode=PowerSave     Tx=Enabled
Status=0080
```

The screen displays the software version and build date, the radio modem's serial number, the list of available DataTAC 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 DataTAC 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 AMSC (American Mobile Satellite Corporation, which operates the ARDIS network in the United States) and BELLMOB (Bell Mobility ARDIS operates a DataTAC network in Canada).

LLI stands for Logical Link Identifier, which is a unique number that identifies each DataTAC radio modem. The LLI 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).

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 latency 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.

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.

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.

0000   The radio modem status is normal. There are no warnings.

0001   The RIM 802D 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 802D 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 off the radio modem then turning it back on will resolve this.

0040   The modem's transmitter has been disabled by your software, using the RAP "Turn Transmitter Off" command. The transmitter can be turned back on with the RAP "Turn Transmitter On" command, or by resetting the radio.

0100   Another device may be using the same LLI 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 LLI number.

0800   The RIM 802D may be having a problem remembering its last base station. If the problem persists, the unit should be returned for repair.

1000   The RIM 802D 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 802D has received an unknown interrupt. No action is necessary.

4000   The RIM 802D 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 802D radio may be used on different DataTAC networks operating on different channels in the 800 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 802D 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. AMSC
                                                   2. BELLMOB
N              Set the current network.
P              Ping: Send a Status SDU to yourself.



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

LLI=88231144  RSSI= 30%  22 dBuV  Battery= 97%    Network=AMSC
Contact=Yes    Mode=PowerSave Tx=Enabled
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 ENTER. Pressing ESC will cancel the network set-up command.

The screen below shows what would happen if you press 2 then ENTER. The values shown beside Network has changed.

```
RIM 802D 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. AMSC
                                                   2. BELLMOB
N               Set the current network.
P               Ping: Send a Status SDU to yourself.



 Your Choice ?

LLI=88231144  RSSI= 30%  22 dBuV  Battery= 97%   Network=BELLMOB
Contact=Yes   Mode=PowerSave Tx=Enabled
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 (SDU – Service Data Unit, a DataTAC data packet) to yourself via the wireless network base station. The MENU utility will display a message indicating that the SDU was sent. A few seconds later, it should also indicate that the SDU was received. This confirms that your radio modem is operational and active on the network.

If you get the message "Status SDU cannot be sent – out of coverage", then you are not in an area that is covered by the DataTAC 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 positioned vertically. 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.

```
RIM 802D 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. AMSC
                                                    2. BELLMOB
N              Set the current network.
P              Ping: Send a Status SDU to yourself.



 Your Choice ?

LLI=88231144  RSSI= 30%  22 dBuV  Battery= 97%   Network=BELLMOB
Contact=Yes   Mode=PowerSave Tx=Enabled
Status=0080

Received SDU from 88231144 (to 88231144)
```

If you are unable to communicate with the network, first 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 SDU 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 DataTAC 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 802D 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 provided.

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 reveals 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 802D OEM radio modem may be stored at a temperature from -40°C to +85°C (-40°F to +185°F).

Operating temperature

The RIM 802D is designed to operate 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 may occur past this point, especially while transmitting.

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

Physical properties

Weight

The RIM 802D weighs 35 g (1.2 oz), including the case.

Dimensions

The RIM 802D 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 (1.65")
- Length: 67.5 mm (2.66")
- Thickness: 8.4 mm (0.33")

⌀2.5±0.1(4X)

| ⊕ | ⌀0.1 | X | Y | Z |

-Y-

36.5 — 2.75

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

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

DIMENSIONS ARE IN: mm

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

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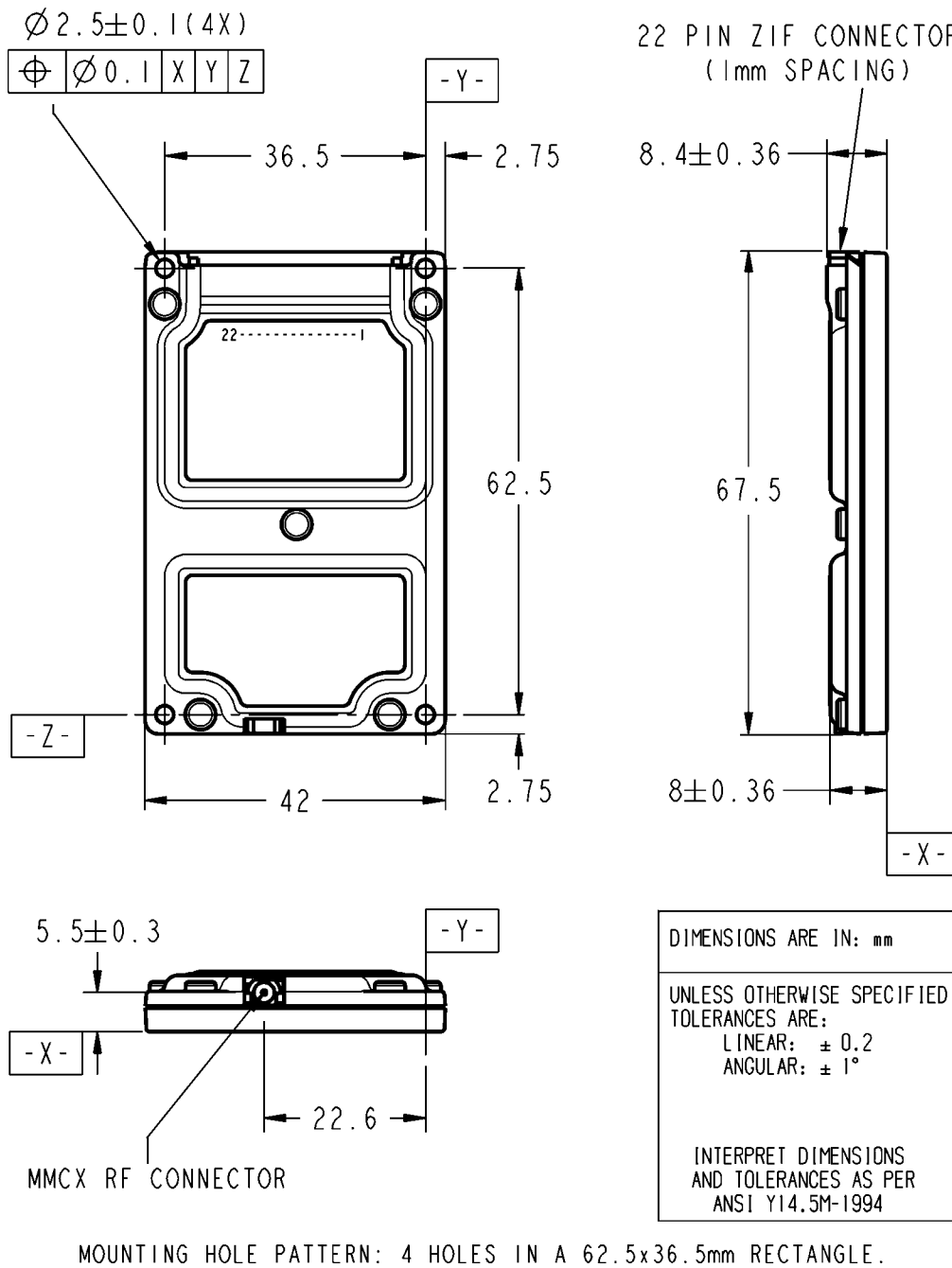
Mounting methods

The RIM 802D OEM radio modem may be securely fastened using a variety of methods. The operating environment must be carefully considered when choosing a mounting option. For example, extreme temperature, heavy vibration, or high electromagnetic interference areas may require a special mounting solution. It is important to ensure that the RIM 802D 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 or standoffs

The RIM 802D radio modem includes a hole in each corner, which may be used to bolt the device onto a circuit board, device housing, stand-offs, 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 for components on your board underneath the radio, you may use standoffs instead of bolts. This is illustrated in the following diagram.

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
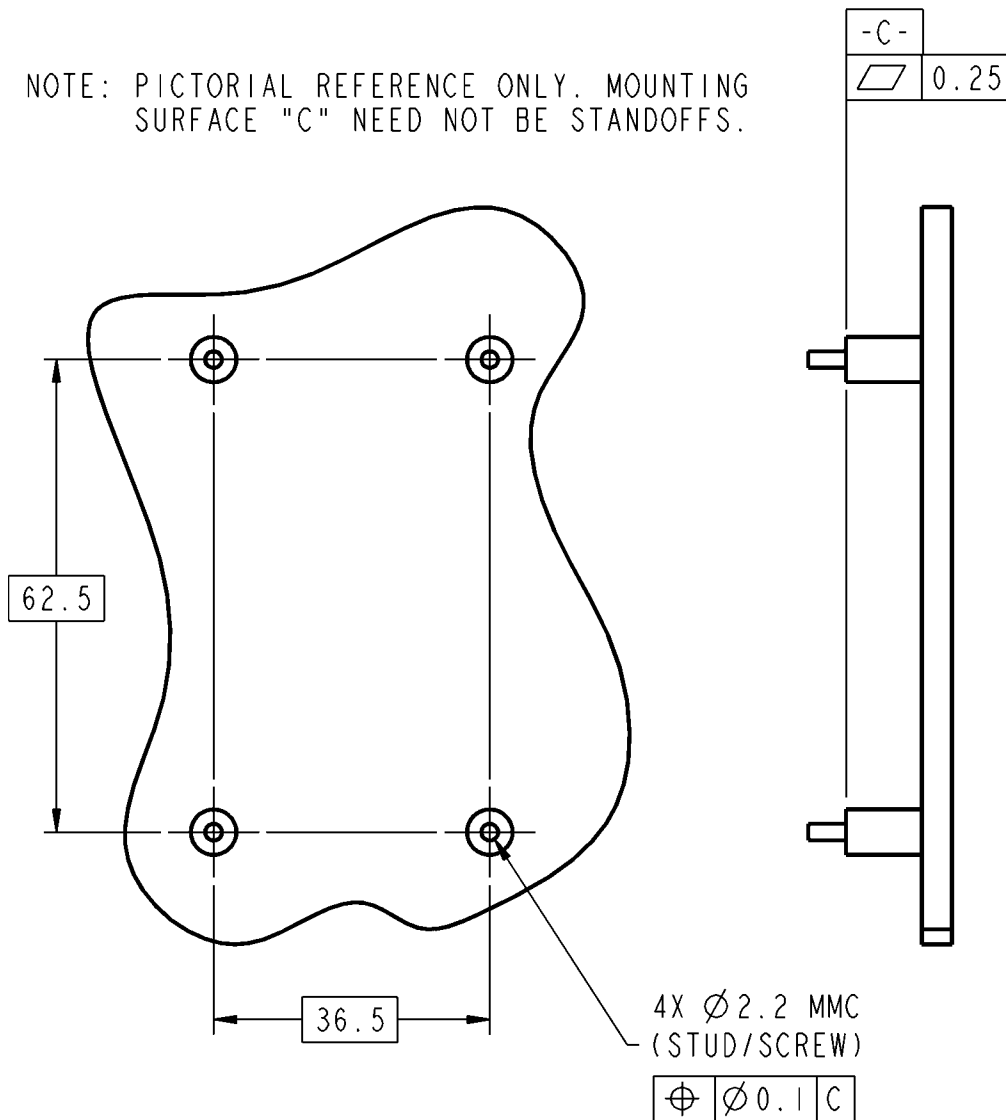
Tie wraps

Tie wraps can be used as a secure but non-permanent means of attaching the RIM 802D to a surface. Typically, each tie wrap passes through a hole drilled

into the surface of your board, on either side of the RIM 802D. 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 802D 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 802D 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 802D 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 802D 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 802D radio modem. One connector is used to interface the radio modem to a serial computing device and a power supply, and a second connector is used to connect 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") thick flexible printed circuit (FPC) cable with 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 interface cable supplied with the RIM 802D Developer's Kit is a Type D 76.2 mm (3.0") long Flat Flex Cable (FFC) Jumper in 1.00 mm centerline spacing, Molex part number 8800-8071, as illustrated in the following mechanical drawing:

THE MOLEX PART NUMBER OF THIS CABLE IS 8800-8071.
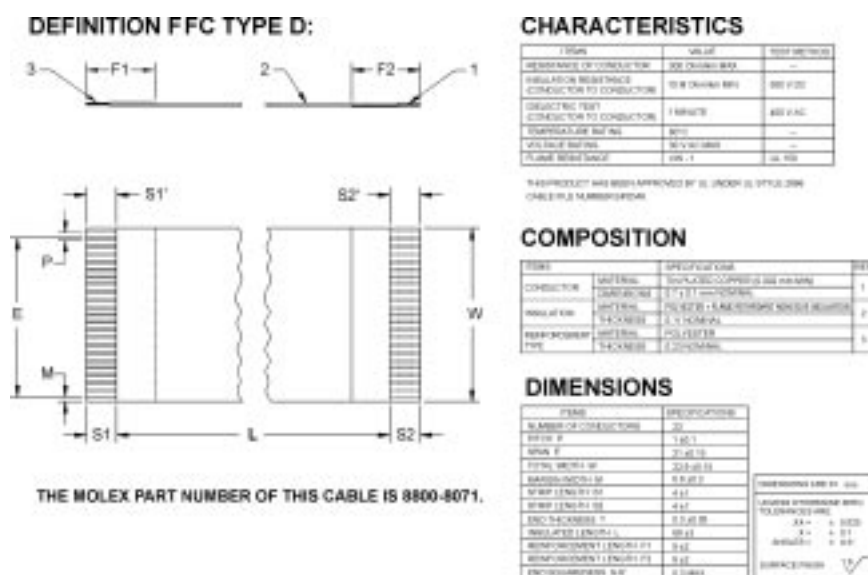
This cable can plug into a matching 22-position 1.0 [0.039] horizontal FPC connector. A variety of connectors are manufactured by Molex. More information about each connector, including mechanical drawings, is available from the manufacturer's web site (www.molex.com), or you can contact RIM (rim802D@rim.net) for help with selecting an appropriate connector for your application.

Contact:

Molex Headquarters
Lisle, IL, USA
tel: (630) 969-4550
fax: (630) 969-1352
www.molex.com

Molex Electronics Ltd.
Toronto, Ontario, Canada
tel: (416) 292-1444
fax: (416) 292-2922

Antenna cable and connectors

RIM uses the industry-standard MMCX connector for the RIM 802D 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 802D. 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 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 802D'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 802D 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 802D.

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
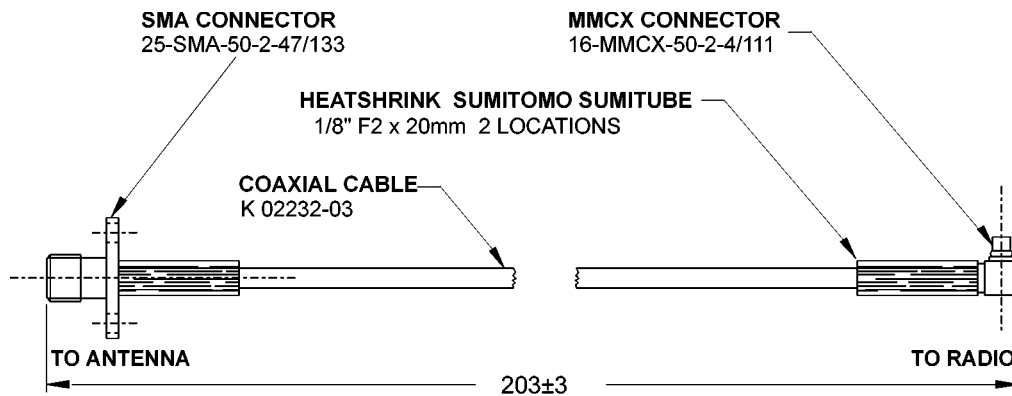
NOTES:

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

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

The following cable is included with the RIM 802D 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

4

Power requirements

The RIM 802D 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 to develop guidelines for integrators who follow design the power supply system for the RIM 802D.

Load specifications

The RIM 802D 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 802D requires a clean, stable 4.1 to 4.75 volt source that is capable of delivering a one-second burst of up to 1.7 A when required by the transmitter. Maximum efficiency is obtained at 4.1V. 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 2.2A. The receiver current consumption is 66 mA. The standby current consumption is 0.2 mA in low-power standby mode and 4.3 mA in regular standby mode.

Radio load profile (at 4.4 V)

Transmitter
    – *transmitting 2.0 W to antenna...*   1.7 A
    – *worst-case peak instantaneous (due to extreme*
      temperature, poorly matched antenna, etc.)...   2.2 A

Receiver   66 mA

Standby   4.3 mA

Low-power Standby   0.2 mA

Transmit duration
    – *minimum...*   32 ms
    – *maximum...*   1 s

Off current consumption $\leq$ 20 µA

Overall power consumption (assume heavy usage)
    – *based on 0.05% transmit, 5.00% receive, and*
      94.95% low-power standby...   4.3 mA
    – *if low-power standby is not used...*   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 and 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, this means that 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, ripple will seem worse. If it is still below 15 mV under these conditions, it will meet the ripple specification.

A passive LC (series L, shunt C) power filter can be put between your power supply and the RIM 802D radio modem to reduce ripple at the radio connector. Bear in mind that the RIM 802D radio 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 RIM 802D at 2.2 A.

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 if a battery with appropriate capacity is to be properly selected.

The current figures below are all measured at a supply voltage of 4.4 V. The actual operating range of the supply voltage is 4.1 to 4.75 V.

Transmitter power usage

The radio transmitter draws 1.7 A to transmit 2.0 W.

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

Receiver power usage

The radio receiver draws 66 mA when it is turned on. However, in Powersave Mode, the receiver is nearly always turned off, and is turned on only occasionally. The base station will wait until the radio's receiver is turned on before attempting to send data to the radio. If no data is waiting at the base station, the radio will turn the receiver off and wait another period of time. This reduces power consumption significantly, but introduces a latency when receiving data packets from the wireless network.

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. This allows two-way interactive applications to process a transaction without delay.

Sending 3 packets in rapid succession will consume 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 will spend less than 0.2% of the time scanning, during which the receiver is turned on. However, a highly mobile application will consume more power than one in a semi-fixed location.

Batteries

When integrated into a handheld device, the RIM 802D 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 the RIM 802D 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 (rim802D@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 RIM 802D. Specifically, they must be able to provide 1.7 A (at 4.4 V) 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, 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 will drop below the minimum power required under load almost immediately following a radio transmit, which would reset the radio each time it tries to transmit.

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 that 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 802D 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 4.1 V and rated for 2.5 A peak current. LIND Electronics (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 4.1V. For sales information, contact Dave Murphy at (612) 927-6303.

Automotive supplies

If you plan to power the RIM 802D 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 802D radio modem.

5

Interface specification

The asynchronous serial interface on the RIM 802D operates at 3.0V, making it compatible with many existing system designs. The RIM 802D can be controlled by a wide variety of microcontrollers and microprocessors, such as the Intel 8051 or 80386, or Motorola 68000. In most cases, the RIM 802D can be connected 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 PC 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.

NCL and RAP link-layer protocols

The RIM 802D requires a serial link-layer protocol to carry data, radio control instructions, and radio status information between the RIM 802D radio modem and the computing device to which it is attached. Two protocols are supported by the radio: Native Control Language (NCL) and Radio Access Protocol (RAP).

If you are using an NCL application with another DataTAC radio and are now migrating to the RIM 802D, you do not need to rewrite the application in RAP – simply continue using the NCL application. If you are writing a new

application for the RIM 802D, you will need to choose whether to use NCL or RAP as your link-layer protocol.

NCL assumes a high-noise environment where bit errors are likely to occur on the serial link between the radio modem and the computing device. NCL 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 802D 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 NCL 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 NCL, 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.

	NCL	**RAP**
Interface cable from RIM 802D 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	5 to 20 kilobytes	1 to 3 kilobytes
Cost	Free, open specification, or pay for third-party APIs	Free, open specification, sample source code is free

There is no "best" protocol. The NCL 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 DataTAC network. The RIM engineering development team (rim802D@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. Input lines 13, 16, 19, and 20 are 5.0 volt input tolerant. Output lines will be capable of driving 5.0 volt systems provided the V_{IH} of these pins is less than 2.5 volts.

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

This section describes the purpose of each of the 22 lines that comprise the interface to the RIM 802D OEM radio modem. The symbol ~ before the label indicates that line is an active low digital signal.

Note that pins 9 through 22 on the RIM 802D correspond to pins 14 through 1 on the RIM 900. The numbering is reversed because the connector is reversed, but physically the leftmost pin on the RIM 802D connector is the same as the leftmost pin on the RIM 900 connector.

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 data packet (SDU) 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.

Pins 7,8 POWER   Power supply

These pins supply power to the radio. Since the current requirement during transmit 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 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. This is a 3.0V input to the radio, and is not 5.0V tolerant. 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 802D is transmitting a packet to the network base station. TRI has a built-in current limiter that allows it to drive an LED directly, 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 will supply 3 mA to a standard LED, and is short-circuit protected. 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 802D 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 NCL implementations, this line indicates that the radio has an NCL frame waiting to transfer to the computing device. This line should also be 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 is an output from the RIM 802D to the computing device. The active (clear to send) state of this line is low.

When asserted low by the RIM 802D, this line indicates that the radio is ready to receive data from the computing device. When this line is high, any data sent from the computing device to the RIM 802D may be lost. This 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 it disconnected.

Pin 16   ~RTS   ~Request To Send

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

All NCL implementations require this line, but it is optional for RAP implementations. This line should be asserted low by the computing device to indicate that it is ready to receive data from the RIM 802D. 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 allows communication.

If your device's buffer overflows, it should set RTS inactive to signal the RIM 802D to pause in sending data. Note that there may 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.

The active (data set ready) state of this line is low. DSR can be used by your computing device as a confirmation that the radio knows the state of the terminal. DSR follows DTR, so the two lines will always be 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.

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 802D. De-asserting this line high will turn communication off; the RIM 802D would not attempt to deliver data to the computing device until ~DTR is again asserted low. Asserting this line low 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 serial transmit activity) 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. The parameters are 8 bits, No parity, 1 stop bit.

Pin 21 RX   Receive

This 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 unit, and should be connected to the host terminal's Receive Data input. This line carries data at 9600 bits per second. The 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 radio 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 802D 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

A controlled shutdown is necessary to allow the RIM 802D to tell the DataTAC network that it is off air. To turn the RIM 802D 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 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.

SDU data that has been received by the RIM 802D from the DataTAC network, but which has not been transferred to the computing device, will not be saved. The SDUs will be lost when the unit enters shutdown or is turned off.

Following this shutdown procedure, it is not necessary to remove power from pins 7 and 8, unless the application cannot tolerate the 0.02 mA current draw that occurs when the radio is shut down.

Loading firmware (optional)

The RIM 802D firmware controls the operation of the radio. RIM is committed to the quality of its firmware, and improvements or optimizations may be made from time to time. The radio is designed so that loading revised firmware is not necessary; two RIM radios with different firmware revisions will always be able to communicate with each other through the wireless network.

Because of its size, firmware cannot be updated over the air. If you decide to implement the ability to update the firmware after the radio is deployed, RIM can provide a DOS or Windows programming utility that loads firmware into the radio. If your device is not DOS or Windows based, the programming utility must reside on a PC or laptop that is connected through its COM port to the radio'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 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 high), and GND.

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 802D.

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 DataTAC network, and for other radio-frequency (RF) systems operating in the 800 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 802D 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 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 802D.

Impedance:	50 Ω

Center frequency:	833 MHz, ±5 MHz *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:	806 to 825 MHz (transmit) 851 to 870 MHz (receive)

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

Supplier contact information

Larsen Antenna Technologies, Inc. Ltd.
Vancouver, WA, USA
tel: (800) ANTENNA / (360) 944-7551
fax: (800) 525-6749 / (360) 944-7556
www.larsenantenna.com

Larsen Antenna Technologies-Canada, Ltd.
Burnaby, B.C., Canada
tel: (800) 663-6734 / (604) 299-8517
fax: (800) 689-2199 / (604) 299-4191

Austin Antenna (subsidiary of World Wireless Communications Inc.)
Salt Lake City, UT, USA
tel: (801) 575-6600
fax: (801) 575-6621
www.worldwireless.com

Centurion International, Inc.
Lincoln, NE, USA
tel: (800) 228-4563 / (402) 467-4491
fax: (800) 826-3774 / (402) 467-4528
www.centurion.com

Andrew Corporation
Orland Park, IL, USA
tel: (708) 349-3300
fax: (708) 349-5444
www.andrew.com

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.

The power output of the RIM 802D is 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 802D is putting out 2.0 W of power to a 2.3 dBd 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 802D 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.

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

Equation 1: Return Loss

The Voltage Standing Wave Ratio (VSWR) is another way of expressing the ratio of incident power (from the RIM 802D) to reflected power (into the RIM 802D).

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

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 802D's frequency range includes 806 to 825 MHz (transmit) and 851 to 870 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 802D is 36.0 cm, and is calculated by dividing the speed of light c = 3 x 10^8 m/s by the center frequency f = 833 MHz. Because the RIM 802D'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 DataTAC 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 802D 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 radio-frequency (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. This will also help the device meet the FCC's RF exposure requirements.

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.

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 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 the RIM 802D provides high immunity to radio-frequency (RF) noise, or 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 802D 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 802D and a computing device, unless the environment contains an extreme level of RF noise (electromagnetic interference). In fact, it would be more important for the power supply to the RIM 802D 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.

FCC radio frequency exposure rules

DRAFT subject to change

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 802D OEM unit 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 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 W/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 mW/cm^2.

How to comply 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 Q 800B (0 dBd gain)

- Andrew (formerly The Antenna Company) Eclipse II Mag Mount (3 dBd gain)

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

If the RIM 802D radio modem is integrated in a vehicle, and if one of these two antennas is used, the MPE limits will not be exceeded provided that the antennas are installed at least 20 cm from any edge of the vehicle rooftop. This can be accomplished by making it mandatory for the customer 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 RIM FCC grant for the RIM 802D limit or restrict to operate in vehicle-mount configurations or substantially equivalent operating conditions. As long as the antenna type, gain, length within 1 inch of those tested for MPE, minimum cable length of 6 ft, and minimum separation distance of 20 cm 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 an antenna with different characteristics, 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 APREL Laboratories for SAR/MPE testing, because of their experience with this type of testing of devices using RIM radio modems. Contact:

Dr. Paul Cardinal
APREL Laboratories
51 Spectrum Way
Nepean, Ontario, Canada
K2R 1E6

Tel: (613) 820-2730
Fax: (613) 820-4161
Email: p.cardinal@aprel.com

During the SAR/MPE testing, the RIM testing software resides on an external PC that requires the ability to communicate with the radio directly. This means that the device you submit for testing must have an external connector that can be used to connect the radio to a PC. If your device can run DOS programs, RIM can provide a DOS-based utility that joins two COM ports. This can be useful if the radio might be connected to a handheld device's internal COM 4 port. There may also be an RS232 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 connected to the internal COM 4, eliminating the need to remove the radio from the handheld device.

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 0.53 mW/cm^2 at 800 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. 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, if antennas other than the two tested by RIM are used.

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 20 cm separation distance is met for the two 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.

For more information

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

> www.access.gpo.gov/nara/cfr/waisidx/47cfr2.html

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

> www.fcc.gov/oet/info/documents/bulletins/#65

Further information concerning the bulletin can be obtained by contacting the RF Safety Group:

> Telephone: (202) 418-2464
> Email: rfsafety@fcc.gov
> Web: www.fcc.gov/oet/rfsafety

Inquiries can also be directed to the FCC's Call Centre. The toll-free number is:

> 1-888-CALL-FCC (1-888-225-5322)

You may contact Research In Motion's engineering development team at:

Email: rim802d@rim.net
Telephone: (519) 888-7465

Specifications

The following is a summary of the RIM 802D 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
- Battery save stand-by mode: 0.2 mA (at 4.4 V)
- Receive / express stand-by mode: 66 mA (at 4.4 V)
- Transmit mode: up to 1.7 A (at 4.4 V, output 2.0W)
- Average current draw (heavy usage: 5% receive, 0.05% transmit, 94.95% standby)
    - 4.3 mA (at 4.4 V) if low-power standby mode is used
    - 8.8 mA (at 4.4 V) if low-power standby mode is not used

RF properties

- Transmit frequency: 806 to 825 MHz
- 2.0 W nominal maximum transmit power at antenna port
- Receive frequency: 851 to 870 MHz
- Receiver sensitivity: -118 dBm(MDC) and –111dBm(RD Lap) at 0.01 bit error rate (BER)
- 8000 bps 0.3 BT GMSK
- FCC Parts 15 and 90 pending
- Industry Canada RSS 119 pending

Serial communications

- 3.0V asynchronous serial port
- 8 bits with no parity (NCL and RAP)
- Link speed: 9600 bps
- Link level protocols:
    - Radio Access Protocol (RAP)
    - Native Control Language (NCL)

Other features

- "MENU" is a simple-to-use firmware utility displays serial number, LLI, RSSI level, battery strength, and network parameters. It can also select different DataTAC 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

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

Glossary of terms

Term:	Meaning:
C	The speed of light.
dB	decibel. A measure of power, based on a logarithmic scale.
FPC	**F**lexible **P**rinted **C**ircuit. The interface cable on the RIM 802D 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.
LLI	**L**ogical **L**ink **I**dentifier. Each DataTAC radio modem has one unique LLI. A LLI is a 32-bit number. The network operator will assign a LLI to each radio modem when they authorize its use on their DataTAC network.
NCL	**N**ative **C**ontrol **L**anguage. The link layer protocol exchanged via an asynchronous full-duplex serial channel between a data terminal or computing device and the RIM 802D OEM Radio Modem.
MMCX	The connector on the RIM 802D to which an antenna cable is connected.
DataTAC	A radio network and its communication protocols.
SDU	**S**ervice **D**ata **U**nit. A parcel of data transferred between the DataTAC network and the radio modem.
Network Operator	The corporation or agency which installs, maintains and authorises use of a DataTAC 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 carried another manufacturer's name. The RIM 802D is designed to be embedded in OEM terminals, PCs, and data gathering equipment.
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 NCL protocol, found on the RIM 802D. Provides simpler implementation.
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) by 5 V. The RIM 802D uses 3.0V 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	**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 the **Antenna Selection** chapter.