RIM GPRS Radio Modem

1902G, 1902GS, 1802G, 1802GS

Integrator Guide

Version 1.0

RIM GPRS Radio Modem 1902G, 1902GS, 1802G, 1802GS Integrator Guide
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Contents

Chapter 1
About this guide

This guide explains how to integrate the RIM GPRS Radio Modem into a variety of devices such as laptop computers, handhelds, vending machines, point-of-sale terminals, vehicle-based mobile terminals, and alarm systems.

This guide includes the following topics:

- integration overview
- test board overview
- mounting requirements
- power (battery) requirements
- interfacing to the RIM radio modem
- antenna selection and placement

Throughout the guide, there are suggestions and precautions that can ease the implementation of a wireless communication solution. To discuss the technical integration of this radio modem, contact RIM at oemsupport@rim.net.

Related documentation

The Integrator's Kit also includes the *RIM GPRS Radio Modem AT Command Reference*, which lists the AT commands that apply to the RIM GPRS Radio Modem.

About this guide

Chapter 2
Introduction to the RIM GPRS Radio Modem

With the introduction of the RIM GPRS Radio Modem, RIM sets a new standard for radio modem performance. Its small size and weight makes it suitable for virtually any wireless data and voice application, including handheld devices and mobile terminals. Its multislot class allows for the highest possible download rates allowed using a single receiver on a GPRS network.

The RIM GPRS Radio Modem consists of the following models:

- 1902G
- 1902GS
- 1802G
- 1802GS

Model	Description
1902G	This model was designed for use with GPRS and GSM wide-area wireless data/voice networks operating in the 1900 and 850 MHz range in the United States, including VoiceStream Wireless and Cingular Interactive. It is identical to the 1902GS, but has an off-board SIM card.
1902GS	This model was designed for use with GPRS and GSM wide-area wireless data/voice networks operating in the 1900 and 850 MHz range in the United States, including VoiceStream Wireless and Cingular Interactive. It is identical to the 1902G, but has an on-board SIM card.
1802G	This model was designed for use with GPRS and GSM wide-area wireless voice and data networks operating in the 1800 MHz and 900 MHz ranges. It is identical to the 1802GS, but has an off-board SIM card.
1802GS	This model was designed for use with GPRS and GSM wide-area wireless voice and data networks operating in the 1800 MHz and 900 MHz ranges. It is identical to the 1802G, but has an on-board SIM card.

Applications

RIM radio modems are designed to integrate easily into a computing device. Potential applications include:

- laptop computers
- vehicle tracking
- point-of-sale devices
- monitoring and telemetry
- ruggedized terminals
- vending machines
- handheld computers
- utility meters
- parking meters
- billboards
- dispatching
- security alarm panels

Radio performance

The RIM GPRS Radio Modem offers very high radio performance for use with GPRS wireless data networks.

Receiver sensitivity

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

Preliminary indications suggest the RIM GPRS Radio Modem has a receiver sensitivity of approximately -107 dBm at 0.01 BER. This means that the radio can interpret received data from a very weak signal (approximately 0.03 picowatt) with a 1% bit error rate. Final values are yet to be determined.

⚠️ **Note:** 1% is an industry standard error rate used to define sensitivity, and does not indicate that 1% of the data passed by the radio to the application is corrupted.

Noise immunity

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

Noise immunity offers several key benefits:

- easier integration
- longer battery life
- increased reliability
- improved RF performance
- more coverage from each base station
- no need for special RF shielding

Powerful and efficient transmitter

When necessary, the RIM GPRS Radio Modem can supply a full 1.0 watt at 1900 MHz. However, the RIM GPRS Radio Modem quickly decreases the output power when it is close to a base station because a stronger signal is needed only when far from a base station. By transmitting a strong signal only when necessary, the RIM GPRS Radio Modem conserves battery power and ensures a balanced link.

Preliminary results indicate that the RIM GPRS Radio Modem provides reliable transmit efficiency across the entire operating voltage range of 3.5 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. Final numbers are yet to be determined.

Small size

Because of its single board design, the RIM GPRS Radio Modem is very thin, and at only 42.0 by 67.5 mm, is smaller than a business card. This tiny size allows the RIM GPRS Radio Modem to meet tight space requirements within most applications. Its single-board design is more reliable than multi-board designs, particularly in high-vibration environments (such as vehicles) or in devices that can be dropped (such as handheld devices).

GPRS network technology

The Global System for Mobile Communication (GSM), first deployed by Oy Radiolinja Ab of Finland in 1992, has become the international voice communication standard. The General Packet Radio Service (GPRS) supplement to the GSM network was first proposed in 1992 in order to converge telecom and datacom. The result has been well received. For further information on GSM and GPRS, please visit http://www.gsm.org.

GPRS is a packet switched overlay to the circuit switched GSM network. This gives a mobile device the ability to be "always on". GPRS allows for a theoretical maximum transfer speed of 171.2 kbps. It is also IP-based, making a mobile device Internet aware.

GPRS networks are deployed worldwide. There are currently 172 countries with deployed GSM networks. These networks can be enabled to perform GPRS communication with the addition of two hardware devices and a software

upgrade. Many GSM network providers have already supplemented their networks with GPRS capability. GPRS technology is deployed or in the process of being deployed in the following countries:

Australia	Germany	Luxembourg	Singapore
Austria	Greece	Malaysia	Slovenia
Belgium	Hong Kong	Malta	South Africa
Canada	Hungary	Netherlands	Spain
China	Iceland	New Zealand	Sweden
Croatia	Ireland	Norway	Switzerland
Czech Republic	Israel	Philippines	Taiwan
Denmark	Italy	Poland	Turkey
Estonia	Lebanon	Portugal	United Arab Emirates
Finland	Liechtenstein	Romania	United Kingdom
French W. Indies	Lithuania	Russia	United States

> **Note:** The RIM 1902G and 1902GS models are compatible with networks in North America that operate in the 1900 and 850 MHz range.
>
> The RIM 1802G and 1802GS models are compatible with networks, usually in Europe, that operate in the 1800 and 900 MHz range.

Introduction to the RIM GPRS Radio Modem

Chapter 3
Getting Started

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

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

⚠ **Note:** The radio modem that is part of the Integrator's Kit is not activated on the GPRS network until a SIM card, which has been activated for GPRS communication, is attached to the device through the proper lines. Contact your GPRS network provider to obtain a SIM card and activate the radio modem.

Working with RIM

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

Phone: +1 (519) 888-7465 ext. 5200
Fax: +1 (519) 883-4940
E-mail: oemsupport@rim.net
Web Site: http://www.rim.net/oem

Integration overview

The following flowchart illustrates the integration process.
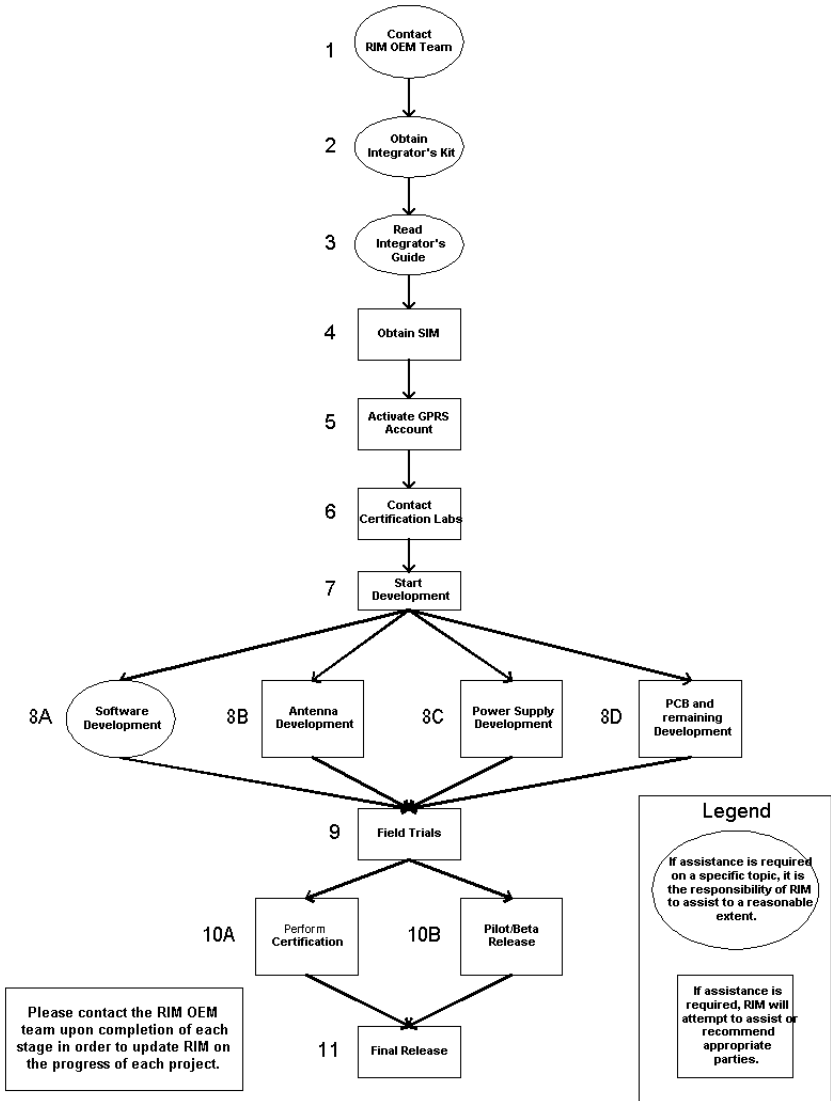
Contact the RIM OEM team

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

Obtain Integrator's Kit

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

Read the *Integrator's Guide*

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

Obtain SIM

Contact the appropriate network provider to obtain a SIM card. For network contact information, visit http://www.rim.net/oem or contact RIM at oemsupport@rim.net.

Activate GPRS account

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

Contact Certification Labs

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

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

Start Development

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

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

Develop Software

RIM will help if you encounter any problems with the communication between the offboard processor and the radio.

Develop an Antenna

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

Develop a Power Supply

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

Complete PCB and Remaining Development

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

Conduct Field Trials

Start product field trials to ensure performance and reliability.

Perform Certification

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

Pilot/Beta Release

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

Final Release

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

Chapter 3: Getting Started

Chapter 4
Setting up the test board

Test board overview

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

The test board includes the following components and functionality.

- RS-232 interface
- On/off switch
- test points
- power supply
- LED indicators
- standard SIM Slot
- microphone/speaker Jack

The test board functionality and components are described below.

RS-232 interface

The serial (COM) port on a computer and most terminal devices operates at RS-232 signal levels, which are typically ±12V. This high voltage would damage the RIM GPRS Radio Modem, 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.

On/off switch

When the switch is on, the radio turns on whenever power is applied to the test board. When the switch is off, the radio shuts down. For more information, see "Turning the radio on and off" on page 53.

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 enables connectivity to analytical equipment—such as a logic probe, multimeter, or oscilloscope—and real-time indication of data flow.

Power supply

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

LED indicators

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

Standard SIM Slot

The test board includes a SIM slot for use with standard 3V SIM cards. The SIM card is necessary in order to access GSM/GPRS networks.

Microphone/Speaker Jack

The test board includes a microphone/speaker jack for use with the headset included in the Integrator's Kit. This allows the integrator to take full advantage of the GSM circuit switched voice network underlying the GPRS networks.

Connecting the test board

You must connect the RIM GPRS Radio Modem to an antenna, SIM card, and a computer, (or another device with a RS-232 serial interface). Use the test board and cables supplied with your Integrator's Kit.

Connecting the test board consists of the following tasks:

1. Connecting the test board to the radio
2. Connecting the SIM to the radio
3. Connecting the test board to the computer
4. Inserting the SIM card
5. Connecting the test board to an AC outlet
6. Connecting the antenna to the radio
7. Turning on the system

The tasks should be completed in the order shown above. They are described below.

Connecting the test board to the radio

Use the 22-pin flat interface cable to connect the test board to the radio.

This interface cable carries most of the data, and all of the voice, between the test board and the radio. Control and status signals such as ONI are also carried on this cable. This cable also carries clean, regulated power to the radio.

When you insert the cable, verify that the side with the bare pins is 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.

Connecting the SIM to the radio

Note: This task only applies to the 1802G and 1902G models.

Use the 6-pin flat SIM interface cable to connect the SIM slot on the test board to the radio. The SIM interface cable carries all of the data and power between the test board SIM slot and the radio modem.

When you insert the cable, verify that the side with the bare pins is in direct contact with the pin side of the connector. For proper contact, do not force the cable into the connector. Instead, pull the tabs on either side of the connector, slide the cable in, and then push the tabs back in to tighten.

Connecting the test board to the computer

Use straight-through DB-9 serial cable to connect the test board to the computer.

Connect the male end of the cable to the test board. Connect the female end of the cable to the computer's COM port.

Inserting the SIM card

You must have a SIM card authorized for use by the appropriate GPRS network provider. The authorization must also allow access to the Access Point Name (APN) that will be targeted.

Slide the SIM card into the slot. Ensure that the leads on the board connect with the conductive surfaces of the SIM card. The SIM card can only be installed one way.

Connecting the test board to an 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.

Connecting the antenna to the radio

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

Connect the antenna cable supplied with your kit from the antenna's SMA plug to the radio's MMCX jack.

⚠ **Note:** 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, for improved performance, place the antenna inear a window, with few obstacles, such as a wall, furniture, or equipment, between the antenna and the window.

Turning on the system

Supply power to pins 7 and 8 on the radio modem to allow the radio modem to power up. However, the power switch on the test board, which controls the TURNON line, can also control whether the RIM GPRS Radio Modem is on.

When the radio is on, the LED marked ONI is lit. The radio can also be turned on using software commands. Refer toRefer to "Chapter 7" on page 45 for more information.

Chapter 4: Setting up the test board

Chapter 5
Integrating the radio modem

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

- environmental properties
- physical properties
- mounting methods
- connectors

Environmental properties

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

During environmental testing, RIM takes samples of its radio modems and subjects them to a variety of harsh conditions. Each unit in the sample is also visually inspected after testing. This experience enables RIM to fine-tune its design and manufacturing process.

Storage temperature

The RIM GPRS Radio Modem can be stored at a temperature from -40°C to 85°C (-40°F to 185°F).

Operating temperature

The RIM GPRS Radio Modem operates between -30°C to 70°C (-22°F to 158°F).

⚠ **Warning:** The end user should be careful not to exceed the upper temperature limit, as performance degradation or damage to the power amplifier can occur past this point, especially during transmission.

Physical properties

Weight

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

Dimensions

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

• Width: 42.0 mm (1.65 inches)

• Length: 67.5 mm (2.66 inches)

• Thickness: 8.4 mm (0.33 inches)

Ø2.5±0.1(4X)
Ø0.1 X Y Z

36.5
2.75
22 PIN ZIF CONNECTOR
(1mm SPACING)
8.4±0.36
-Y-

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.
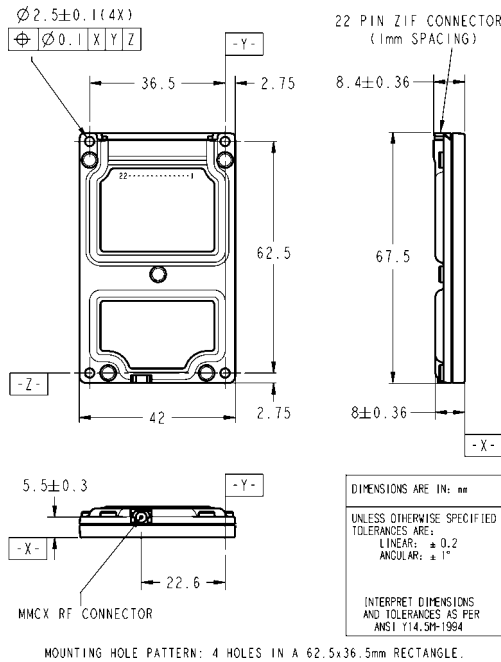
Mounting methods

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

This section describes the following mounting methods:

• bolts or standoffs

• tie wraps

• permanent industrial adhesive

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

Bolts or standoffs

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

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

RADIO MOUNTING DETAILS

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

-C-
0.25

62.5

36.5

4X Ø2.2 MMC
(STUD/SCREW)
Ø0.1 C
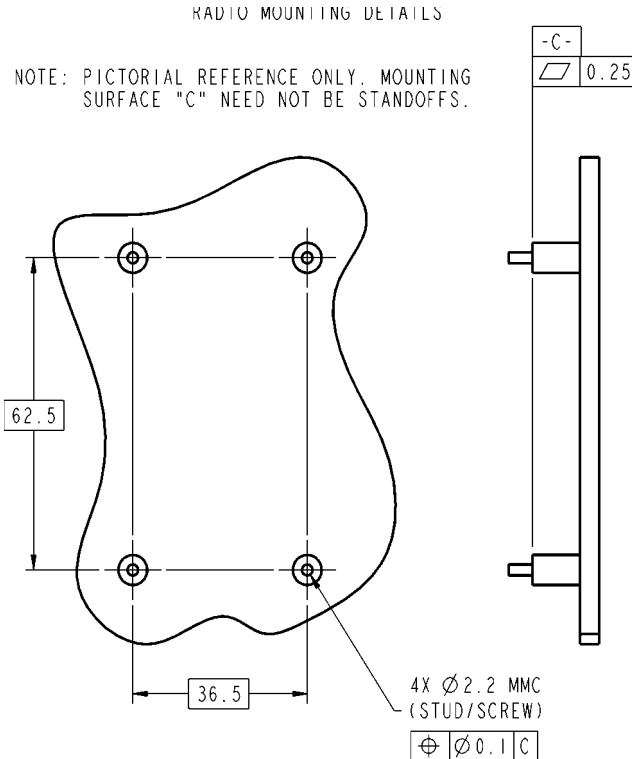
Tie wraps

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

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

Permanent industrial adhesive

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

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

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

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

Cables and connectors

The radio modem has the following connectors:

• radio interface connector

- SIM interface cable (G models only)

- antenna connector

Radio interface cable and connector

The radio interface connector connects the radio modem to a serial computing device, speaker and microphone, and power supply. Serial communication data, control signals, and power are carried on a flat 22-conductor 0.30 mm (0.012 inches) thick flexible printed circuit (FPC) cable with 1-mm centerline spacing, which can plug into a matching connector.

Because each application is unique, it may be necessary to create a custom Flat Flex Cable (FFC) Jumper with the correct length and correct connector orientation for your application. Please refer to the diagram in the next section for FPC specifications.

The interface cable supplied with the Integrator's Kit is a Type D 76.2 mm (3.0 inches) long FFC Jumper with 1 mm centerline spacing, Molex part number 210390382.

This cable can plug into a matching 22-position 1.0 [0.039] horizontal FPC connector. AMP/Tyco Electronics manufactures a variety of connectors. For information about each connector, including mechanical drawings, visit the manufacturer's web site (www.amp.com), or contact RIM (oemsupport@rim.net) for help selecting an appropriate connector for your application.

SIM interface cable and connector

⚠️ **Note:** The SIM interface cable and connector are only required for the 1902G and 1802G models.

The SIM interface cable and connector connects a SIM card to the radio modem. All SIM communication data and power are carried on a flat 6-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.

Because each application is unique, it may be necessary to create a custom Flat Flex Cable Jumper with the correct length and connector orientation for your application. Please refer to the following diagram for FPC specifications:

Required FPC Specifications

mm [inch]
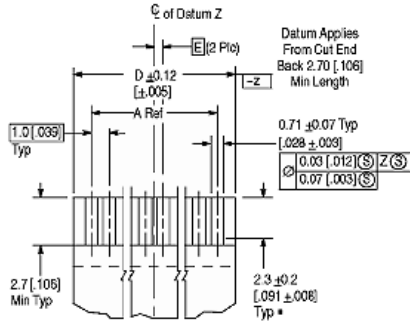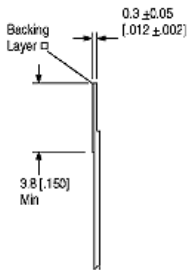
NUMBER OF POSITIONS	DIMENSION A	DIMENSION D	DIMENSION E
6	5.0 [.197]	7.0 [.276]	0.50 [.020]
22	21.0 [.827]	23.0 [.906]	0.50 [.020]

The 6-pin interface cable supplied with the RIM GPRS Radio Modem Developer's Kit is a 76.2 mm (3.0") long Flat Flex Cable (FFC) Jumper with 1.00 mm centerline spacing and same side conductive surfaces, Parlex part number 100-6-76-B.

This cable can plug into a matching 6-position 1.0 [0.039] horizontal FPC connector. A variety of connectors are manufactured by AMP/Tyco Electronics, including AMP part number 487951-6. For information about each connector, including mechanical drawings, visit the manufacturer's web site (www.amp.com), or contact RIM (oemsupport@rim.net) for help with selecting an appropriate connector for your application.

Contact:

Amp / Tyco Electronics
General Information
Harrisburg, PA, USA
tel: (800) 522-6752
fax: (717) 986-7575
www.amp.com

Molex Headquarters   Molex Electronics Ltd.
Lisle, IL, USA   Toronto, ON, Canada
Tel: (630) 969-4550   Tel: (416) 292-1444
Fax: (630) 969-1352   Fax: (416) 292-2922
email: amerinfo@molex.com
http://www.molex.com

Parlex Corporation
Flexible Circuits Products
Methuen, MA, USA
tel: (978) 685-4341
fax: (978) 685-8809
email: flexcircuits@parlex.com
www.parlex.com

Antenna cable and connectors

The antenna cable and connector connects the antenna to the radio modem. RIM uses the industry-standard MMCX connector for the RIM GPRS Radio Modem. The MMCX connector is very small, and it has the mating force to withstand heavy vibration.

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

The antenna cable should have low loss, an impedance of 50 Ω, and an MMCX jack that mates with the RIM GPRS Radio Modem's MMCX plug. The other end of the cable can be any connector with an impedance of 50 Ω. An SMA screw-on connector is suitable and widely available. TNC connectors are also suitable, but

larger than SMA. The antenna cable supplied with the Integrator's Kit has an MMCX connector on one end and an SMA connector on the other. The cable is built with strain reliefs to prevent damage.

Huber & Suhner provides antenna cables and connectors. The parts described below have an impedance of 50 Ω and are suitable for use with the RIM GPRS Radio Modem.

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

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

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
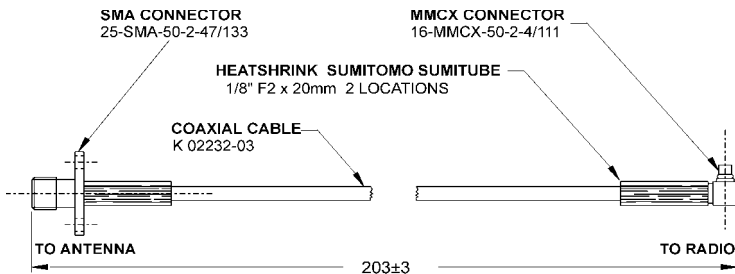
NOTES:

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

Contact:

Huber & Suhner   Huber & Suhner
Essex Junction, VT, USA   Kanata ON, Canada
Tel: (802) 878-0555   Tel: (800) 627-2212
Fax: (802) 878-9880   Fax: (613) 596-3001
http://www.hubersuhnerinc.com

Chapter 6
Power Requirements

The RIM GPRS Radio Modem requires a clean power source capable of delivering bursts of high current. This power source can be provided by a plug-in power supply unit, a rechargeable battery pack, or by single-use batteries.

Load specifications

The RIM GPRS Radio Modem draws its power in bursts; the power required changes rapidly depending on whether the radio is transmitting, receiving, or idle.

Power supply parameters

Preliminary indications are that the RIM RIM GPRS Radio Modem requires a clean, stable 3.5 to 4.75 volt source that is capable of delivering a one-second burst of up to 2 A when required by the transmitter. Final numbers are yet to be determined. RIM recommends designing a more robust power supply that can provide adequate power under such non-ideal conditions as an improperly matched antenna, under which this burst could be as high as 2.2 A.

For the RIM GPRS hardware integration to be fully compatible with the RIM 902M and RIM 802D radio modems, ensure the power input to the radio modem is above 4.1 Volts. Please contact the RIM OEM Engineering Development team for further details on backwards compatibility.

Ripple specification

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

Except in special cases where there are several sources of ripple, measure the ripple with an oscilloscope set to 1-MHz bandwidth; the peak-to-peak value is not to exceed 15 mV.

⚠️ **Note:** If there are several ripple components, or if ripple is measured with a larger (typically 20-MHz) bandwidth, the ripple seems worse. If the ripple is still below 15 mV under these conditions, it meets the ripple specification.

You can place a passive LC (series L, shunt C) power filter between your power supply and the RIM radio modem to reduce ripple at the radio connector. The radio modem already has approximately 70 µF of on-board shunt capacity. 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 3.5 V to the radio modem at 2.2 A.

Batteries

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

Rechargeable batteries

Nickel cadmium

RIM recommends using rechargeable nickel cadmium (NiCad) batteries to power the RIM GPRS Radio Modem for battery-operated applications that require a wide operating temperature range. Nickel metal hydride (NiMH) and lithium ion (Li+) cells can also be used with good results, but many such cells do not work very well at temperatures below freezing. Batteries specifications should be obtained from the manufacturer.

The selected cells must be able to meet the radio modem load specifications. Specifically, they must be able to provide 2.0 A (at 4.2 V) for transmission. Rechargeable cells vary considerably, because capacity varies with current draw. Even if two cells have the same published capacity, one might not be as efficient as another when the radio transmitter is turned on. This is because some batteries have a higher equivalent series resistance (ESR) at high current drain. The ESR should be low enough that the battery can supply the transmission current required without a large voltage drop.

Alkaline

You can also use rechargeable alkaline batteries. These cells are typically rated for about 25 discharge cycles, far fewer than NiCads, but they provide longer life than NiCads. For the first five to ten cycles, you will receive about 70 to 80 percent of the battery life you would expect from a single-use alkaline cell. After 25 discharges, this number may drop to 50 percent.

⚠ **Warning:** You must take precautions with alkaline rechargeable batteries. These cells are not intended to be used to their full capacity, so their actual useful runtime 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.

⚠ **Warning:** The use of general-purpose carbon-based batteries is strongly discouraged; 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 load characteristized by bursts. If a carbon-based battery is used, the voltage drops below the minimum power required under load almost immediately following a radio transmission, which resets the radio each time it tries to transmit.

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

Plug-in supplies

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

Preliminary indications suggest a supply capable of providing at least 3.5 V and rated for 2.2 A peak current is recommended. Final numbers are yet to be determined.

Automotive supplies

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

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

Chapter 6: Power Requirements

Chapter 7
Interface specification

The asynchronous serial interface on the RIM GPRS Radio Modem operates at 3.0V, making it compatible with many existing system designs.

The radio modem can be controlled by a wide variety of microcontrollers and microprocessors, such as the Intel 8051 or 80386, or Motorola 68000. In most cases, the RIM GPRS Radio Modem 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 will 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.

The RIM GPRS Radio Modem is compliant with GSM Phase 2/2+ specifications. For detailed information on the AT command structure, please refer to the *RIM GPRS Radio Modem AT Command Reference Guide* included in the Integrator's Kit.

AT Commands

Command	Description
V.25ter	The V.25ter commands correspond to the basic commands of AT Hayes-compatible modems applicable for GSM 07.07. Examples of such commands include answering incoming calls, switching modes, and redialling.
GSM 07.07	The GSM 07.07 commands are for remote control of GSM functionality, including phone book functionality. Example of such commands includes selecting bearer service types, entering PIN's, and changing passwords.
GSM 07.05 for SMS	The GSM 07.05 commands are for performing SMS and CBS related operations for both Text and PDU modes. Examples of such commands include deleting, transmitting, and saving SMS messages.
GSM 07.07 for GPRS	The GSM 07.07 for GPRS AT commands are required for all GPRS functionality such as PDP context definitions and activations, QoS definitions and requests, GPRS attaches and detaches, PDP address retrieval, GPRS Mobile Station class retrieval, event reporting, network registration status retrieval, and SMS messaging services.

SIM Interface Pins

Note: The SIM interface Pins only apply to models with off-board SIM cards.

This section describes the purpose of each of the 6 lines that comprise the SIM interface to the 1902G and 1802G radio modems. All SIM Interface lines are 3.0 volt logic. The 1902G and 1802G radio modems' software polls the SIM card to confirm its presence.

Note: For proper operation, the SIM connector cable should be no more than 10cm long.
The VPP line on the SIM card connector can be shorted with the VCC line to continue proper operation.

Pin	Description
1	VCC. This line supplies the SIM with power. Verify that it leads to the VCC pin of the SIM card connector. It may be necessary to filter noise on the line to prevent a fault from occurring. Please refer to the diagram in the next section as an example.
2	Reset. This is an output from the radio. Verify that it leads to the Reset pin of the SIM card connector.
3	Clock. This is an output from the radio. Verify that it leads to the Clock pin of the SIM card connector.
4	Input/Output. This is a bidirectional line between the SIM card connector and the RIM GPRS OEM radio modems. Verify that it leads to the I/O pin of the SIM card connector.
5	SIM Detect. The active state of this line is high. This line should be asserted in order to ensure the radio modem can detect the SIM card.
6	Ground. This is an input to the radio. Short this line to the GND pin of the SIM card connector.

The following diagram shows an example of how the SIM was incorporated onto the RIM Integrated Test Board:
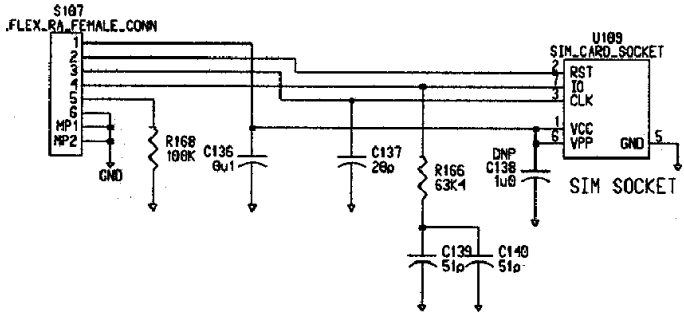
Radio Interface Pins

This section describes the purpose of each of the 22 lines that comprise the radio interface to the RIM GPRS Radio Modem.

Overview

Pins 1-4

Pins 1 to 4 were introduced to take advantage of the GPRS data network's underlying GSM voice infrastructure. The differential nature of the analog lines provides high voice quality and noise immunity.

Pins 5-22

Input and output lines from pins 5 to 22 are 3.0 volt logic; however, they will also be able to drive 3.3 volt systems. Input lines 16, 19, 20, and 22 are 5.0 volt input tolerant. Output lines will be capable of driving 5.0 volt systems provided the VIH of these pins is less than 2.5 volts.

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

⚠ **Note:** Pins 5 to 22 are identical to those of the RIM 802D/902M.

Serial ports

There are two serial ports on the RIM GPRS Radio Modem.

- The primary serial port uses pins 20 and 21 for transmit and receive and is used to carry AT commands and data between the radio modem and the computing device.

- The secondary serial port uses pins 13 and 22 for transmit and receive and may be used only by a custom application that resides on the radio modem itself, never AT and data traffic. Flow control lines are provided for the primary serial port only.

⚠️ **Note:** The symbol ~ before the label indicates that line is an active low digital signal.

Pin descriptions

The following table lists each pin and describes it in detail.

Pin	Label	Description
1	MIC N	This pin is not used in this release.
2	MIC P	Analog Microphone Input This is an analog input to the radio.
3	SPK N	Audio Ground This is an analog reference signal for pin 2 and pin 4.
4	SPK P	Speaker Signal. This is an analog speaker output from the radio.
5	MSG	Message Waiting This line is a digital output from the radio. The active state of this line is high, and indicates that the radio modem has received a packet, which has not been delivered to the device application yet, from the network. This line remains active until the application acknowledges receiving the packet. When the radio modem receive buffer is full, this line is inactive (low).
6	COV	Coverage This line is a digital output from the radio. The active state of this line is high, and the radio modem is in network coverage, as determined by the presence of a signal from the network base station. When the radio modem does not have contact with the wireless network, this line is low.
7, 8	—	Power supply These pins supply power to the radio. Since the current requirement during transmission exceeds the current rating of a single line, both lines 7 and 8 should be connected to the power supply. Supplying power to these two lines allows the radio to turn on.

Pin	Label	Description
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.
10	TURNON	Turn Radio On This line 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 for the power supply to the radio modem. This is a 3.0 V input to the radio, and is not 5.0 V tolerant. Please note that the functionality of the TURNON line can be performed through AT commands as well. Refer to "Turning the radio on and off" on page 53 for more information.
11	ONI	On Indicate This line is a digital output from the radio that indicates that the radio is on and operational. This line can be used by a computing device to qualify the handshaking outputs on the serial interface. If CTS is low, and ONI is high, then the unit is ready to receive data, but if CTS is low and ONI is low, then the radio modem is not ready to receive data because it is off. When ONI is low, all inputs to the radio modem should be held low or disconnected. Otherwise, power is consumed and wasted.
12	TRI	Transmit Indicate The active (radio transmitting) state of this line is high. This output from the radio modem is asserted while the radio is transmitting a packet to the network base station. TRI has a built-in current limiter that enables it to directly drive an LED , which provides real-time visual feedback that the radio is transmitting packets. If this is not necessary, you can leave the line disconnected. This line supplies 3 mA to a standard LED, and is short-circuit protected. This line is low when the radio modem is off.
13	RX2	Secondary Receive This line is an input to the radio modem. Its idle (no serial transmit activity) state is high. This line is an asynchronous serial output from the radio modem, and may be connected to a computing device's Transmit Data output. This line carries data at a maximum of 115 200 bits per second, 8 bits, No parity, 1 stop bit. This line is meaningful only as part of a debug port primarily for RIM internal use.

Pin	Label	Description
14	~RI	~Ring Indicate
		This line is an output from the radio modem.
		When ~DTR is not asserted (high), the radio modem asserts ~RI (low) to indicate that it has data waiting for the computing device. The radio modem does not transfer the data until ~DTR is asserted (low). This line can be used to wake up a suspended computing device when the radio modem needs to communicate with it. If ~DTR is already asserted (low) when the radio modem has data to send the computing device, ~RI is not asserted.
15	~CTS	~Clear To Send
		This line is a digital output from the radio modem to the computing device. The active (clear to send) state of this line is low.
		When asserted low by the radio modem, this line indicates that it is ready to receive data from the computing device. While this line is high, any data sent from the computing device to the RIM GPRS Radio Modem may be lost. This line is a flow control mechanism that is normally reacted to by the UART in your serial communication system. If you do not plan to use it, leave ~CTS disconnected.
16	~RTS	~Request To Send
		This line is an input to the radio modem. The active, request to send, state of this line is low.
		This line should be asserted low by the computing device to indicate that it is ready to receive data from the radio modem. This is a flow control mechanism that is normally handled by the UART in your serial communication system. If you do not connect this line to your UART, it must be tied low so that it is permanently asserted and enables communication.
		If your device buffer overflows, it should set RTS inactive to signal the radio modem to pause sending data. There might be a 16-byte overrun after the RTS line is made inactive, so your device should set RTS inactive at least 16 bytes before any critical buffer overflows.
17	~DSR	~Data Set Ready
		This line is a digital output from the radio modem.
		The active, data set ready (DSR), state of this line is low. Your computing device can use DSR as a confirmation that the radio modem knows the state of the terminal. DSR follows DTR, so the two lines are always at the same voltage.
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.

Chapter 7: Interface specification

Pin	Label	Description
19	~DTR	~Data Terminal Ready This line is a digital input to the radio. The active, data terminal ready (DTR), state of this line is low, and indicates that the computing device is ready to receive data from the radio modem. De-asserting this line high turns communication off; the radio modem does not attempt to deliver data to the computing device until ~DTR is again asserted low. If you do not intend to use ~DTR, tie it to ground to ensure that it is always asserted during radio modem operation. This line should be driven low when the radio modem is off. Driving ~DTR high when the radio modem is off will consume unnecessary power.
20	RX	Receive This is an input to the radio. Its idle (no serial receive activity) state is high. This line is an asynchronous serial output from the radio modem, and should be connected to the host terminal's Receive Data input. This line carries data at a maximum of 115 200 bits per second. Parameters are 8 bits, No parity, 1 stop bit. This baud rate can be changed using the proper AT command.
21	TX	Transmit This line is an output from the radio modem. Its idle (no serial receive activity) state is high. This line is an asynchronous serial output from the radio modem, and should be connected to the host terminal's Transmit Data output. This line carries data at at a maximum of 115 200 bits per second. Parameters are 8 bits, No parity, 1 stop bit. The baud rate can be changed using the proper AT command.
22	TX2	Secondary Transmit This line is for RIM internal use only.

Warning: All unused inputs to the radio should be tied to ground, and any unused outputs from the radio should be left disconnected.

Turning the radio on and off

To determine the current state of the radio, observe the ONI line. If ONI is high, the radio is on or in the process of shutting off. If ONI is low, the radio is off or in the process of turning on. 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. There are also AT commands that can turn the radio on and off in the same manner as the TURNON line.

Turning the radio on

There are two ways to turn the radio on. Either set TURNON to high, or transmit the appropriate AT command through the serial communications port.

During the startup procedure of the RIM radio modem, which can take several seconds, all AT commands and changes to TURNON will be ignored by the operating system.

Do not use theTURNON to indicate radio status. ONI must be used as the indicator of the radio status. It is possible for the radio to be off even though TURNON is asserted. In this case, the radio can be turned on through the appropriate AT command, or by setting TURNON low and then high again.

If the radio fails to respond to a high TURNON line or the proper AT command, 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 of the RIM radio modem is necessary. There are two ways to turn the radio off. Either de-assert TURNON, or transmit the appropriate AT command through the serial communications port.

During the shutdown procedure of the RIM radio modem, which can take several seconds, all AT commands and changes to TURNON will be ignored by the operating system.

Do not use the TURNON state to indicate radio status. ONI must be used to indicate radio status. It is possible for the radio to be on even though TURNON is de-asserted. In this case, the radio can be turned off through the appropriate AT command, or by setting TURNON high and then low again.

⚠️ **Note:** 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.

Data that has been received by a RIM GPRS Radio Modem from the network, but has not been transferred to the computing device, will not be saved. The data will be lost when the unit enters shutdown or is turned off.

It is not necessary to remove power from pins 7 and 8, unless the application is very power constrained.

Resetting the Radio

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

Loading firmware (optional)

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

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

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

Chapter 7: Interface specification

RIM GPRS Radio Modem

Chapter 8
Antenna selection

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

The antenna that you choose should suit your project's needs. There are many different antenna types and options that will meet your engineering and user requirements and remain 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 GPRS network, and for other radio-frequency (RF) systems operating in the same frequency range. RIM does not recommend specific antennas because the choice of antenna is application-dependent.

The performance of an antenna depends on its configuration and environment; the same antenna will behave differently from device to device, even if these devices use the same RIM radio modem. For example, magmount antennas include a magnetic base that allows the antenna to clamp onto a metal surface. This surface is called a ground plane, and it reflects

electromagnetic radiation that would otherwise be lost to the antenna. This reflection effectively doubles the length of the antenna by creating a virtual "mirror image" of the antenna beneath the plane.

Antenna requirements

The following are the minimum requirements of the antenna system used with the RIM GPRS radio modems. Further minimum requirements are pending.

Ffor the RIM GPRS Radio Modem hardware integration to be fully compatible with the RIM 902M and RIM 802D radio modems, the antenna must be modular. GPRS has several frequency bands, 1900, 1800, 900, and 850, each of which requires its own antenna. Additionally, GPRS, Mobitex, and DataTac networks have different center frequencies. If the same antenna is used for all three networks, receiver sensitivity is greatly affected. Please contact the RIM OEM Engineering Development team for further details on backwards compatibility.

The RIM GPRS Radio Modem requires an impedance of 50 Ω .

Introduction to antenna terminology

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

Gain and ERP

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

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

At the antenna port, the output power of the RIM GPRS Radio Modem is as high as 1.0 W at the antenna port. The antenna gain (or loss) results in an increase (or decrease) in this value. The actual output from the antenna is called the Effective

Radiated Power, or ERP. For example, if the radio modem delivers 2.0 W of power to a 2.3 dBd gain antenna, the ERP is $2.0 \times 10 \wedge (2.^{3 \div 10}) = 3.4$ 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 GPRS Radio Modem is 50 Ω, which is a widely-available industry standard. Any deviation from this value may result in impedance mismatch and signal loss.

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

Antenna mismatch can be expressed as a Return Loss (RL), which is 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 to express the ratio of incident power (from the radio modem) to reflected power (into the radio modem).

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

Equation 2: VSWR

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

VSWR and RL normally vary as a function of frequency.

Antenna size

The optimal antenna radiation efficiency is produced by an antenna measuring one wavelength, l. The value of l for the RIM GPRS Radio Modem is calculated by dividing the speed of light $c = 3 \times 10^8$ m/s by the center frequency.

Antenna lengths of λ/2, λ/4, and λ/8 also work well, and usually result in a relatively well matched antenna. λ/2 or λ/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 antenna positioning maximizes the gain provided by the antenna. When you determine the proper position, 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.

When you are designing an antenna, you should consider the following issues:

- vertical polarization
- proximity to active electronics
- transmit interference
- device position
- antenna cable

These issues are discussed below.

Vertical polarization

The GPRS network is based on vertically polarized radio-frequency transmission. Therefore, the antenna should be oriented to provide vertical polarization. This polarization is achieved by positioning the antenna vertically upward when the

radio modem is in use. In small, hand-held devices, it may be convenient to design the unit in such a way that the antenna folds out of the way when not in use.

Proximity to active electronics

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

Transmit interference

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

Device position

• If the computing device is designed to sit on a surface, the antenna should be as far from the bottom of the device as possible. This reduces 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 user's body, the antenna should be positioned to radiate away from the body. Otherwise, the body absorbs the radiated energy and the effective coverage area of the radio is reduced. Positioning the antenna away from the body also helps the device meet the FCC's RF exposure (SAR/MPE) requirements.

Antenna cable

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

Additional notes

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

"There are a number of critical issues to consider when integrating antennas into portable RF systems. It is important to make allowances early in the design process to optimize performance and provide flexibility in antenna choice. Generally, it is prudent to position the antenna "up and away" from the radio modem and printer motors to maximize noise reduction and receiver desensitivity. Other "high noise" areas to be avoided include displays and keypads that can seriously degrade antenna performance. Advances in antenna shielding techniques may also be incorporated to retain the integrity of the system.

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

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

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

Shielding

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

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

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

Note: Circuits with a high impedance, and sensitive analog circuits, are especially vulnerable to nearby radio frequency emissions, and may need to be shielded. Circuits like CRTs and LCD display drivers are typically affected.

Chapter 8: Antenna selection

RIM GPRS Radio Modem

Chapter 9
Specifications

The following is a summary of the RIM GPRS radio modems specifications.

Power supply & typical current usage

Preliminary values. Final values are yet to be determined

- Single power supply; operating range: 3.5 to 4.75V DC

- Transmit mode: up to 2 A (at 4.2V, output 1.0W)

RF properties

- Transmit frequency: 1850 to 1910 MHz and 824 to 829 MHz

- 1.0 W nominal maximum transmit power at antenna port

- Receive frequency: 1930 to 1990 MHz and 869 to 894 MHz

- Transmitter can reduce output power when near a base station as per GSM specifications

- Preliminary receiver sensitivity: -107 dBm at 2.4% error rate (BER)

- Multislot Class 8

Serial communications

- 3.0V asynchronous serial port

- Second 3-wire serial port (TX, RX, GND)
- Link speed: 1200 to 115,200 bps

Other features

- ARM Processor running at 32.5 MHz
- Software can activate/deactivate radio
- Flow control options: Hardware, Xon/Xoff, or None
- Radio parameters stored at power down
- Terminal devices may power-down while radio-modem remains operational
- Fully shielded metal enclosure

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 connectors: 22 pin FPC (Flexible Printed Circuit) connector and 6 pin FPC connector
- Antenna cable connector: MMCX
- Metal case
- Preliminary operating temperature: -30°C to +70°C (at 5-95% relative humidity, non-condensing)
- Preliminary storage temperature: -40°C to +85°C

Chapter 10
Glossary

Chapter 10: Glossary

Term	Meaning
APN	Access Point Name. GPRS network provider's name for a given external network.
CBS	Cell Broadcast Service. Unacknowledged general short messages to all receivers within a defined geographical area
dB	Decibel measures power based on a logarithmic scale. 10 dB = 10 times, 3 dB = 2 times, −10 dB = 0.1 times.
FPC	Flexible Printed Circuit. The interface cable on the RIM GPRS Radio Modem 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.
GMSK	The modulation scheme used by airlink communication on GPRS communication. Allows theoretical data rates of 14.4 kbps per timeslot.
GPRS	General Packet Radio Service. The IP-based data network that supplements the existing GSM voice networks throughout the world.
GSM	Global System for Mobile Communications. A second generation voice communication network standard accepted throughout the world.
IP	Internet Protocol. Standard network layer protocol used over many networks including the GPRS network and the Internet.
MMCX	The connector on the RIM GPRS Radio Modem to which an antenna cable is connected.
Network Operator	The corporation or agency that installs, maintains and authorizes use of a GPRS network in a given area, usually within one country.
Noise	Undesired, random interference combining with the signal. If the device is not immune to noise, the interference must be overcome with a stronger signal strength. Noise can be produced by electronic components.
OEM	Original Equipment Manufacturer. Usually implies that the "OEM product" carries another manufacturer's name. The RIM GPRS Radio Modem is designed to be embedded in OEM terminals, PCs, and data gathering equipment.
OSI	The Open Systems Interconnection model allows different systems, following the applicable standards, to communicate openly with each another.

Term	Meaning
Polarity	Direction of current flow. Connecting some cables with the wrong polarity (i.e. backward) may damage the device.
QoS	Quality Of Service.
Radio Modem	A device that provides *mo*dulation and *dem*odulation for a radio frequency communications system.
Radiation	In this document, refers to electromagnetic energy emitted in the radio frequency (RF) band.
Return Loss	A measure of antenna matching.
RF	Radio Frequency.
RS-232	The standard asynchronous serial communications interface used by most existing personal computers and mini-computers. Usually refers to both the communications protocol and the electrical interface.
RSSI	Received Signal Strength Indicator. A high RSSI represents a strong signal received by the radio modem from the base station.
SIM	Subscriber Identity Module. A SIM is necessary in order to activate a GSM/GPRS device on the network.
SMS	Short Message Service. Messaging services over the circuit-switched GSM networks, up to a maximum of 160 characters.
TTL	Transistor-Transistor Logic. Used in digital circuits. Low (0) is represented by 0 V and High (1) by 5 V. The RIM RIM GPRS Radio Modem uses 3.0V for High.
UART	Universal Asynchronous Receiver/Transmitter. Used as an interface between a microprocessor and a serial port.
VSWR	Voltage Standing Wave Ratio. A measure of antenna matching. Refer to "Antenna selection" on page 57 for more information.

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