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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Important Safety and compliance information

This section provides information on the following topics:

- FCC compliance statement (USA)
- Industry Canada Certification

FCC compliance statement (USA)

FCC Class B Part 15

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

- This device may not cause harmful interference, and
- 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 manufacturer's instructions, may cause interference harmful 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:

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

Industry Canada Certification

This device complies with Industry Canada RSS 133, under certification number 2503A-R6020GN.

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

Chapter 1
Introduction to the RIM GPRS Radio Modem

This section provides information on the following topics:

- About the RIM GPRS Radio Modem
- GPRS network technology

About the RIM GPRS Radio Modem

With the introduction of the RIM GPRS Radio Modem, Research In Motion® (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 is designed for use with GPRS and GSM wide-area wireless data/voice networks operating in the 1900 and 850 MHz range in North America. It is identical to the 1902GS, but it has a 6-pin zif connection, which allows you to position the SIM card in the location that best suits your design.
1902GS	This model is designed for use with GPRS and GSM wide-area wireless data/voice networks operating in the 1900 and 850 MHz range in North America. It is identical to the 1902G, but it has an on-board SIM card.
1802G	This model is designed for use with GPRS and GSM wide-area wireless voice and data networks operating in the 900 MHz and 1800 MHz ranges. It is identical to the 1802GS, but it has a 6-pin zif connection, which allows you to position the SIM card in the location that best suits your design.
1802GS	This model is designed for use with GPRS and GSM wide-area wireless voice and data networks operating in the 900 MHz and 1800 MHz ranges. It is identical to the 1802G, but has an on-board SIM card.

The RIM GPRS Radio Modem offers the following advantages:

- range of applications
- radio performance
- reciever sensitivity
- noise immunity
- powerful and efficient transmitter
- small size

These advantages are described below.

Range of applications

RIM radio modems are designed to integrate easily into a computing device and are suitable for a wide range of applications, including:

- 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

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.

The RIM GPRS Radio Modem typically has a receiver sensitivity of -107 dBm with a 2.4% bit error rate (BER).

Note: BER is an industry standard error rate used to define sensitivity; it does not indicate that 2.4% of the data that is 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 the radio modem is far from a base station. By transmitting a strong signal only when it is 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. The transmit efficiency 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 most applications' tight space requirements. The radio modem's 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 to combine telecom and datacom, and the result has been well-received. For more information on GSM and GPRS, visit `http://www.gsm.org`.

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

GPRS networks are deployed worldwide. There are currently 172 countries with deployed GSM networks. Enabling GPRS communication on GSM networks requires only two additional hardware devices and a software upgrade. Many GSM network providers have already supplemented their networks with GPRS capability. GPRS technology is deployed or is 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 900 and 1800 MHz range.

Chapter 2
Getting Started

This section provides information on the following topics:

- about the Integrator Kit
- working with RIM
- integration overview

About the Integrator Kit

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 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 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.

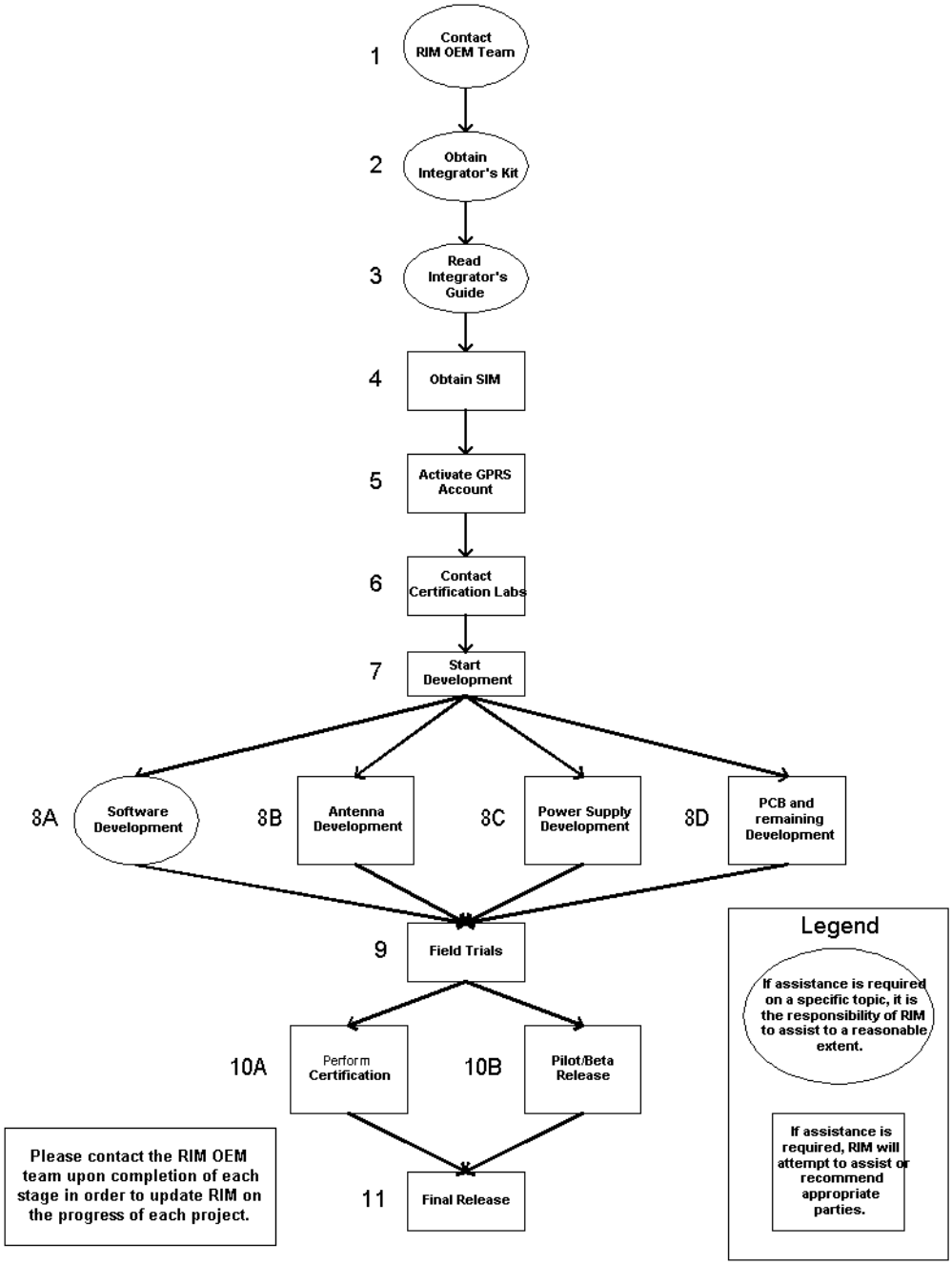
Working with RIM

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
email: `oemsupport@rim.net`
web site: `http://www.rim.net/oem`

Integration overview

The following flowchart illustrates the integration process.



Step	Description
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 Kit	Request the Integrator Kit from Research In Motion. This kit includes the radio modem, two mechanical samples of the radio, an interface and test board, AC to DC power supply, required cables, magnetic mount antenna, and documentation.
Read the *Integrator Guide*	Read the *Integrator Guide* first to make sure that you follow proper procedures to prevent unnecessary delays and equipment damage. 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 will help you to avoid redesign costs. 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.

Step	Description
Develop Software	Contact RIM if you encounter any problems with the communication between the offboard processor and the radio.
Develop an Antenna	Start developing an antenna. The antenna that is provided with the Integrator Kit has been certified for use with the RIM GPRS Radio Modem. If this antenna does not meet your needs, develop an antenna for use with the final product. Refer to the *Integrator Guide* for guidelines selecting an antenna.You can also 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 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 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 make sure 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 specific guidelines that must be followed prior to certification to make sure that the release conforms to legal requirements.
Final Release	Congratulations on completing the development process! Contact RIM if you encounter any obstacles related to the RIM GPRS Radio Modem. Please also provide RIM with regular updates on the release's progress.

Chapter 3
Setting up the test board

This section provides information on the following topics:

- Test board components
- Setting up the test board (GS models)
- Setting up the test board (G models)

Test board components

The RIM test board provides a standard RS-232 serial interface between a computer and the radio modem. The test board allows you to connect 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 components and functionality are described below.

Component	Description
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 computer.
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. Refer to "Turning off and turning on the radio" on page 58 for more information.
Test points	The test board is more than an RS-232 interface. 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 data flow indication.

Component	Description
Power supply	The RIM GPRS Radio Modem requires a clean, high-current power source. RIM uses a standard plug-pack to provide the current that is 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 light emitting diode (LED) indicators that are designed to indicate the flow of data to and from the host (in real time), the radio power status, power to the test board, network coverage, and more.
Standard SIM card holder	The test board includes a SIM card holder for use with standard 3V or 5V 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 that is included in the Integrator Kit. The microphone/speaker jack enables the integrator to take advantage of the GSM circuit-switched voice network that underlies the GPRS networks.

Setting up the test board (GS models)

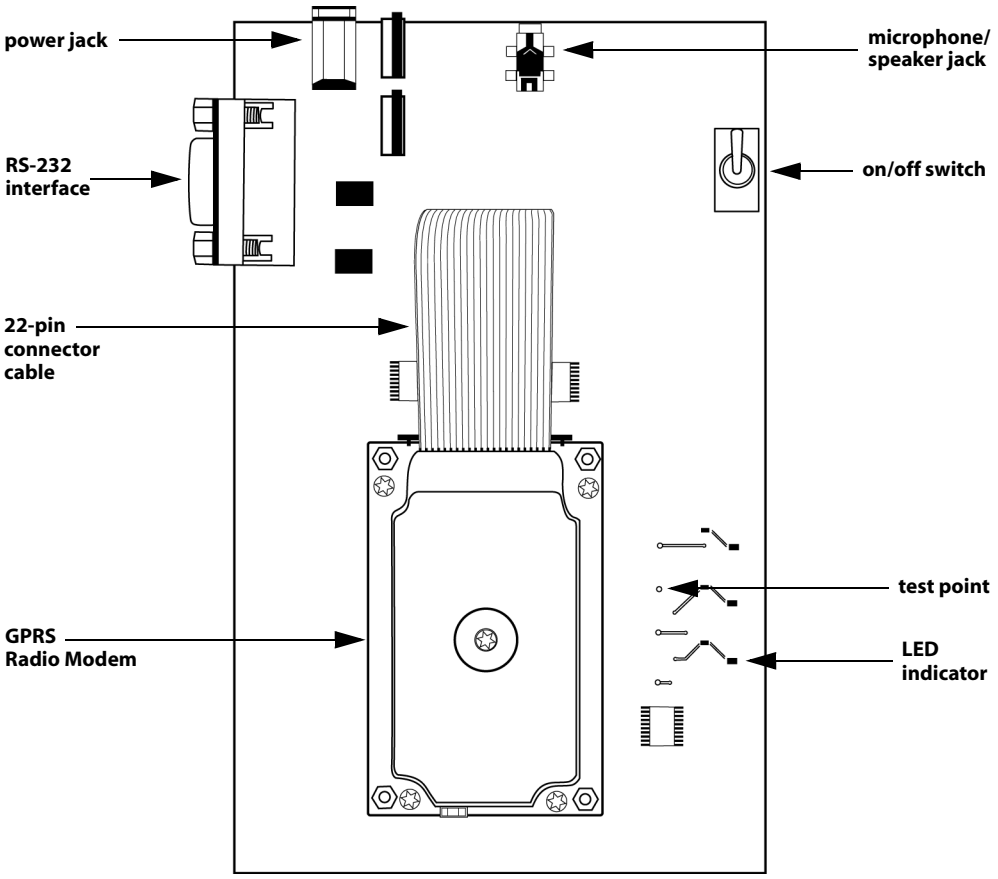
To use the test board that is provided with your Integrator Kit, you must connect the RIM GPRS Radio Modem to an antenna, SIM card, and a computer (or another device with a RS-232 serial interface). Use the test board and cables that are supplied with your Integrator Kit.

Note: These steps apply to on-board SIM models (GS) only.

To set up the test board, complete these tasks in the following order:

1. Connect the radio modem to the test board.
2. Connect the test board to the computer.
3. Insert the SIM card into the SIM card holder.
4. Connect the antenna to the radio modem.
5. Connect the test board to an AC outlet.
6. Turn on the system.
7. Connect the headset.

The following graphic illustrates the GS model test board and major components.



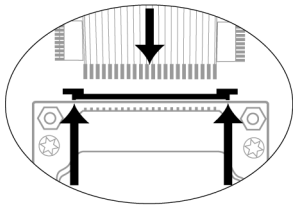
GS model test board — top view

To connect the radio modem to the test board

Note: This step is only necessary if the radio modem is not already connected to the test board.

The 22-pin flat interface cable supplies clean, regulated power to the radio and carries most of the data and all of the voice between the test board and the radio modem. This cable also carries control and status signals, such as `ONI`.

1. At the top of the radio modem, push the two black tabs up and away from the connector.



Connecting the 22-pin cable to the radio modem

2. With the blue side facing the test board, insert the end of the 22-pin cable into the connector. Verify that the side with the bare pins is in direct contact with the pin side of the connector.

Note: Do not force the cable into the connector.

3. At the top of the radio modem, push the black tabs down toward the connector to secure the cable.
4. Repeat steps 1 through 3 for the 22-pin connector on the test board.

To connect the test board to the computer

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

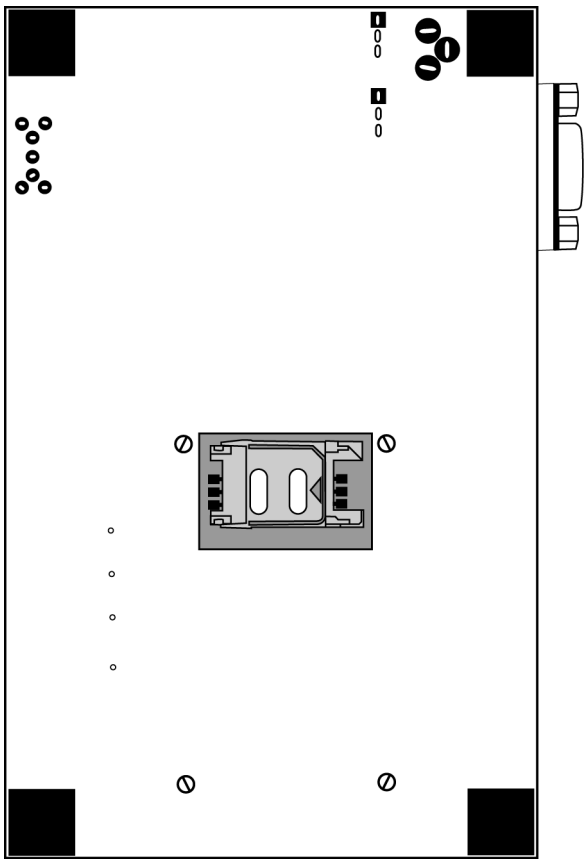
Connect the male end of the cable to the test board. Connect the female end of the cable to an available COM port on the computer.

To insert the SIM card into the SIM card holder

Warning: To prevent damage to your SIM card, do not scratch or bend the card or expose it to static electricity or wet conditions.

Note: You must have a SIM card that is 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.

1. Turn the test board over to reveal the cut-out that provides access to the SIM card holder on the underside of the radio modem.



Underside of the test board showing the on-board SIM card holder

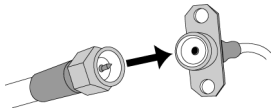
2. Slide the SIM card holder in the direction of the arrow to unlock it, and then lift the cover open.
3. Slide the SIM card into the cover with the conductive side facing the leads on the board. The notched end of the SIM card should align with the notch in the SIM card holder.
4. Close the cover, and then slide the cover in the reverse direction of the arrow to lock it into place.

To connect the antenna to the radio modem

Note: If you connect the antenna before you connect the test board to an AC outlet, the unit detects network coverage more reliably.

The Integrator Kit includes a high-performance, 3 dB-gain magmount antenna, which is terminated by a screw-on SMA plug. The radio modem includes a snap-on MMCX jack.

1. Insert the antenna into the base and turn the antenna until the two components are securely fastened.
2. Insert the SMA cable connector into the MMCX connector and turn the SMA connector until the two components are securely fastened.



SMA cable connector and MMCX connector

3. Insert the MMCX connector into the radio modem's MMCX jack.
4. Position the antenna for optimal coverage. The magmount antenna provides optimum RF performance when it is placed on a broad metal surface, such as the roof of a car. If you are using the antenna inside a building, for improved performance, place it near a window, with few obstacles (such as a wall, furniture, or equipment) between the antenna and the window.

To connect the test board to an AC outlet

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

To turn on the system

Switch the power switch to the `TURNON` position to allow the radio modem to power up.

When the radio is on, the LED marked `ONI` is lit. Refer to "Turning off and turning on the radio" on page 58 for more information.

To connect the headset

Insert the headset plug into the audio jack.

Setting up the test board (G models)

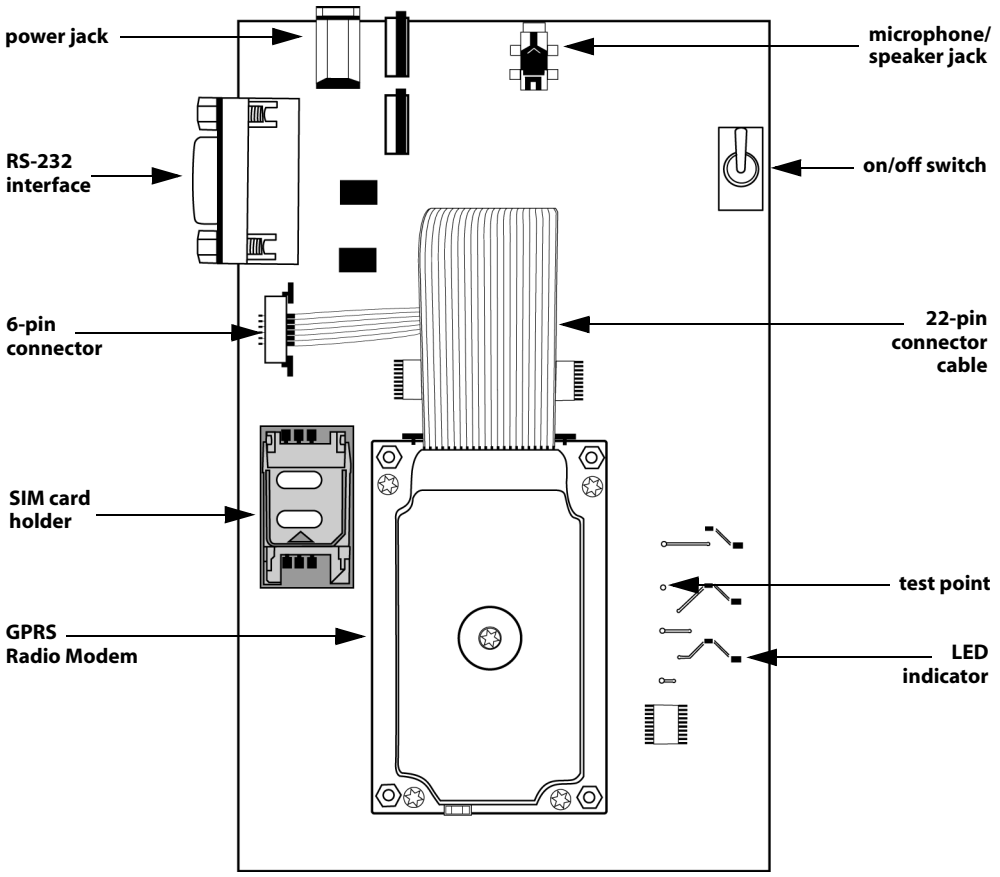
To use the test board that is provided with your Integrator Kit, you must connect the RIM GPRS Radio Modem to an antenna, SIM card, and computer (or another device with a RS-232 serial interface). Use the test board and cables that are supplied with your Integrator Kit.

Note: These steps apply to off-board SIM models (G) only.

To set up the test board, complete these tasks in the following order:

1. Connect the SIM card to the test board.
2. Connect the radio modem to the test board.
3. Connect the test board to the computer.
4. Insert the SIM card into the SIM card holder.
5. Connect the antenna to the radio modem.
6. Connect the test board to an AC outlet.
7. Turn on the system.
8. Connect the headset.

The following graphic illustrates the G model test board and major components.



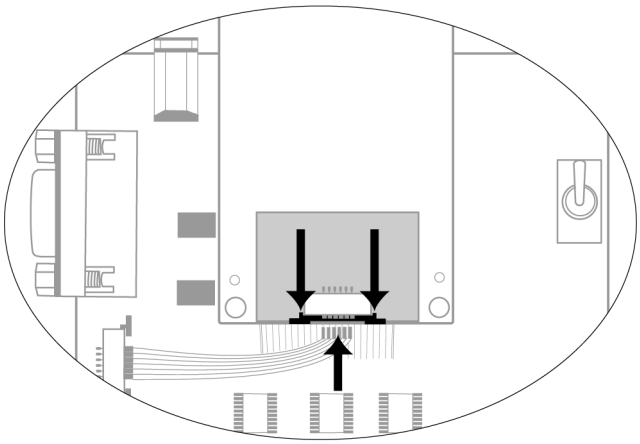
G model test board — top view

To connect the SIM card to the test board

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

The 6-pin flat SIM interface cable carries the data and power between the test board SIM slot and the radio modem.

1. Remove the radio modem from the test board: unfasten the nuts and lift the radio modem up and away from the test board.
2. On the underside of the modem, on the connector, push the two black tabs up from the connector to widen the opening.



Underside of radio modem showing the 6-pin connector

3. With the blue side facing the test board, insert the end of the cable 6-pin cable into the connector. Verify that the side with the bare pins is in direct contact with the pin side of the connector.

Note: Do not force the cable into the connector.

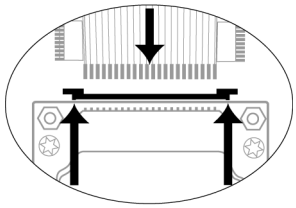
4. Push the black tabs down toward the connector to secure the cable.
5. Repeat steps 2 through 4 to connect the 6-pin connector to the test board.
6. Re-attach the radio modem to the test board.

To connect the radio modem to the test board

Note: This step is only necessary if the radio modem is not already connected to the test board.

The 22-pin flat interface cable supplies clean, regulated power to the radio and carries most of the data and all of the voice between the test board and the radio modem. This cable also carries control and status signals, such as `ONI`.

1. At the top of the radio modem, push the two black tabs up and away from the connector.



Connecting the 22-pin cable to the radio modem

2. With the blue side facing the test board, insert the end of the 22-pin cable into the connector. Verify that the side with the bare pins is in direct contact with the pin side of the connector.

Note: Do not force the cable into the connector.

3. At the top of the radio modem, push the black tabs down toward the connector to secure the cable.
4. Repeat steps 1 through 3 for the 22-pin connector on the test board.

To connect the test board to the computer

Use the 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.

To insert the SIM card into the SIM card holder

Warning: To prevent damage to your SIM card, do not scratch or bend the card or expose it to static electricity or wet conditions.

Note: You must have a SIM card that is 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.

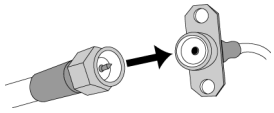
1. Slide the SIM card holder in the direction of the arrow to unlock it, and then lift the cover open.
2. Slide the SIM card into the cover with the conductive side facing the leads on the board. The notched end of the SIM card should align with the notch in the SIM card holder.
3. Close the cover, and then slide the cover in the reverse direction of the arrow to lock it into place.

To connect the antenna to the radio modem

Note: If you connect the antenna before you connect the test board to an AC outlet, the unit detects network coverage more reliably.

The Integrator Kit includes a high-performance, 3 dB-gain magmount antenna, which is terminated by a screw-on SMA plug. The radio modem includes a snap-on MMCX jack.

1. Insert the antenna into the base and turn the antenna until the two components are securely fastened.
2. Insert the SMA cable connector into the MMCX connector and turn the SMA connector until the two components are securely fastened.



SMA cable connector and MMCX connector

3. Insert the MMCX connector into the radio modem's MMCX jack.
4. Position the antenna for optimal coverage. The magmount antenna provides optimum RF performance when it is placed on a broad metal surface, such as the roof of a car. If you are using the antenna inside a building, for improved performance, place it near a window, with few obstacles (such as a wall, furniture, or equipment) between the antenna and the window.

To connect the test board to an AC outlet

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

To turn on the system

Switch the power switch to the TURNON position to allow the radio modem to power up.

When the radio is on, the LED marked ONI is lit. Refer to "Turning off and turning on the radio" on page 58 for more information.

To connect the headset

Insert the headset plug into the audio jack.

Chapter 4
Integrating the radio modem

This section provides information on the following topics:

- Overview
- Environmental properties
- Storage temperature
- Operating temperature
- Physical properties
- Mounting methods
- Cables and connectors

Overview

This section provides you with information on issues that you should consider when you are developing your application's hardware. You can use this information and the additional components provided with the Integrator Kit as a resource as you develop your application's hardware.

The Integrator Kit includes several components that can help you develop your product's housing and physically integrate the radio modem and associated hardware into your your application. These components consist of two 22-pin connector cables, two 6-pin connector cables (G models only), and two radio modem mechanical samples.

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 75° C (-22° F to 158° F).

Warning: You should warn end users not to exceed the upper temperature limit; doing so can result in performance degradation or damage to the power amplifier, especially during transmission.

Physical properties

Weight

The RIM GPRS Radio Modem weighs 36 g (1.2 oz), including the case.

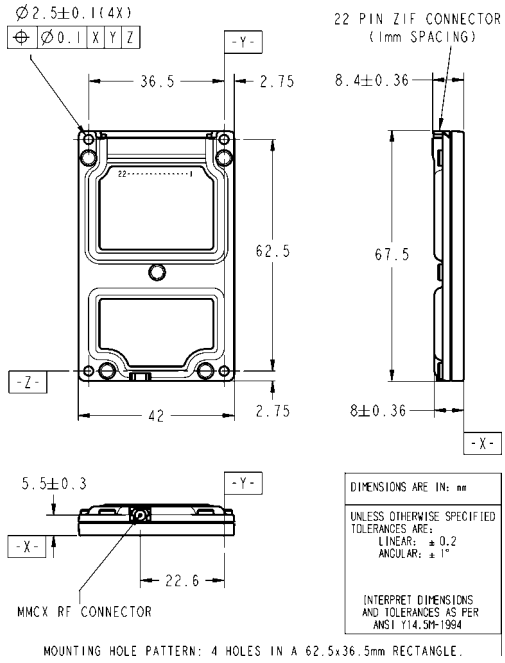
Dimensions

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

Width 42.0 mm (1.65 inches)

Length 67.5 mm (2.66 inches)

Thickness 8.4 mm (0.33 inches)



Mounting methods

RIM GPRS Radio Modems can be securely fastened using a variety of methods; however, you must consider the operating environment when you choose a mounting option. For example, extreme temperature, heavy vibration, or areas with high electromagnetic interference can require a special mounting solution. You must make sure that the radio modem remains securely attached in the environment where it is used.

This section describes the following mounting methods:

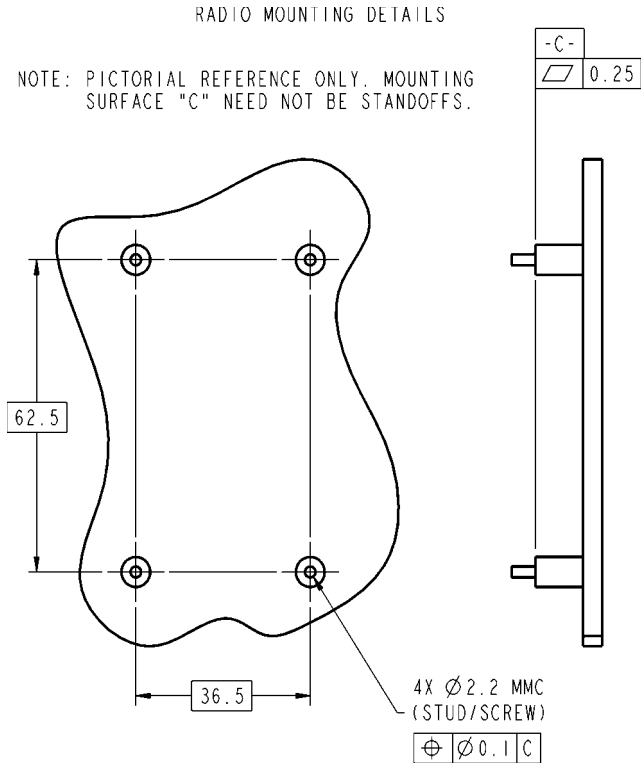
- bolts or standoffs
- tie wraps
- permanent industrial adhesive

The following information is presented as a guide; however, applications can vary considerably. A mechanical engineer can help you make sure that the mounting method that you choose is suitable for your application.

Bolts or standoffs

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

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



Tie wraps

You can also use tie wraps 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 board's surface on either side of the radio modem. This enables the radio to be attached to a shell, a PCB, or other mounting surfaces.

Warning: If you use tie wraps, make sure 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 radio modem's metal case to flex upward and short components inside the radio. To avoid this 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 radio modem's outer casing and the surface to which the radio modem will be mounted. The RIM GPRS Radio Modem's bottom casing is magnesium.

Note: You should choose foam tape for rough surfaces and adhesive tape for smooth surfaces.

Cables and connectors

The radio modem includes the following connectors:

- radio interface connector
- SIM interface connector (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. This cable has 1-mm centerline spacing that can plug into a matching connector.

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

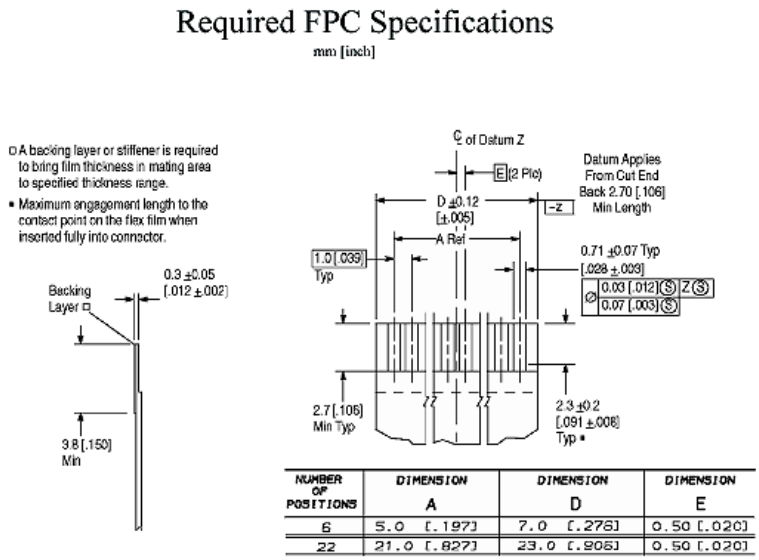
Note: The interface cable supplied with the Integrator Kit is a Type D 76.2 mm (3.0 inches) long FFC Jumper with 1 mm centerline spacing, Molex part number 210390382.
This cable can plug into a matching 22-position 1.0 [0.039] horizontal FPC connector. AMP/Tyco Electronics manufactures a variety of connectors. 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. This cable has 1.00 mm centerline spacing that can plug into a matching connector.

Because each application is unique, you may need to create a custom Flat Flex Cable Jumper that has the correct length and connector orientation for your application. Please refer to the diagram below for FPC specifications.



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]

FPC interface cable specifications

Note: The 6-pin interface cable supplied with the Integrator 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.

Antenna cable and connectors

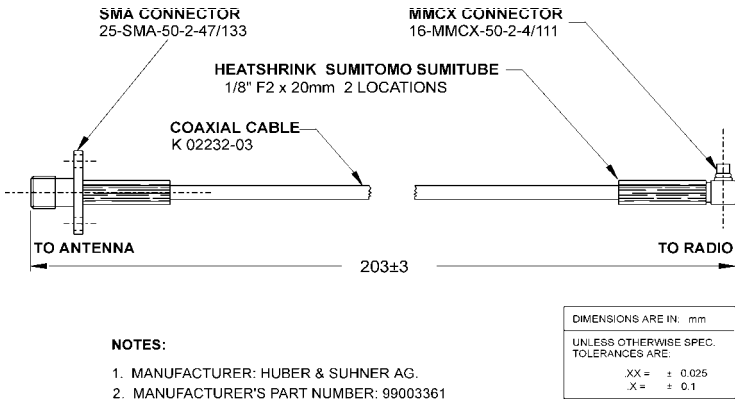
The antenna cable and connector connects the antenna to the radio modem. RIM uses the industry-standard MMCX connector for the RIM GPRS Radio Modem. The MMCX connector is very small, and it has the mating force to withstand heavy vibration.

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 device's outer casing. 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 that you use should have low loss, an impedance of 50 Ω, and an MMCX plug that mates with the RIM GPRS Radio Modem's MMCX jack. 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 they are larger than SMA connectors.

Note: The antenna cable supplied with the Integrator 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.

The following cable is included with the Integrator Kit:



Integrator Kit antenna cable

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

Contact:

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

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

Chapter 5
Power Requirements

This section provides information on the following topics:

- Load specifications
- Power requirements
- Batteries
- Plug-in supplies
- Automotive supplies

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

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 it is required by the transmitter. RIM recommends that you design 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.

If you want your RIM GPRS hardware integration to be fully compatible with the RIM 902M and RIM 802D radio modems, make sure that 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, RIM recommends ripple of less than 15 mV peak-to-peak (measured at the radio end of the connector) across the frequency range 60 Hz to 1 MHz. The maximum ripple at the connector that can be tolerated is 20 mV peak-to-peak.

Except in special cases where there are several sources of ripple, you should 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 appears to be worse than it is. 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.

Power requirements

The RIM GPRS Radio Modem requires a clean power source that is capable of delivering bursts of high current. You can provide this power source through the following sources:

- a rechargeable battery pack or single-use batteries
- a plug-in power supply unit
- an automotive supply

These sources are discussed below.

Batteries

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

Rechargeable batteries

Nickel cadmium

For battery-operated applications that require a wide operating temperature range, RIM recommends using rechargeable nickel cadmium (NiCad) batteries to power the RIM GPRS Radio Modem. You can also successfully use nickel metal hydride (NiMH) and lithium ion (Li+) cells. However, many of these cells work poorly at temperatures below freezing. Batteries specifications should be obtained from the manufacturer.

The cells that you use must be able to meet the radio modem load specifications (refer to page 46); they must be able to provide 2.0 A (at 4.2 V) for transmission. Rechargeable cells vary considerably; even if two cells have the same published capacity, one might be less efficient than 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 that 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 they require the user to pay closer attention to the battery state. If you fully discharge a rechargeable alkaline battery, you may only get five recharges before the capacity decreases to the point where it can no longer be used.

Single-use batteries

Of the single-use cells, only alkaline and lithium cells provide the high current necessary for transmission. However, AA alkaline cells are likely the best choice. They are inexpensive, widely available, and provide an excellent power source. Alkaline cells typically run for approximately four times longer than similar-size NiCad cells and for approximately three times longer than similar-size NiMH cells.

Warning: RIM strongly discourages the use of general-purpose carbon-based batteries; this type of battery cannot 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 that users of your product 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. You must design your plug-in supply to make sure that voltage spikes, lightning, and other power fluctuations cannot damage the radio modem. To keep the inputs within the limits given in the radio modem load specifications (refer to page 46), you can add transient voltage protection zener diodes or other spike arrestor circuits. 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 the intense power fluctuations that occur when an automobile starts. You should use a circuit that consists of inductors, transorbs and voltage regulators to make sure 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 GPRS Radio Modem.

Chapter 6
Interface specification

This section provides information on the following topics:

- RIM GPRS Radio Modem interface
- AT Commands
- SIM Interface Pins
- Radio Interface Pins
- Turning off and turning on the radio
- Loading firmware (optional)

RIM GPRS Radio Modem interface

The asynchronous serial interface on the RIM GPRS Radio Modem operates at 3.0V, which means that it is 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 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. These commands include answering incoming calls, switching modes, and redialling.
GSM 07.07	The GSM 07.07 commands are used to remotely control GSM functionality, including phone book functionality. These commands include selecting bearer service types, entering PINs, and changing passwords.
GSM 07.05 for SMS	The GSM 07.05 commands are used to perform short message service (SMS) and CBS related operations for both Text and PDU modes. These 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, including PDP context definitions and activations quality of service (QoS) definitions and requests GPRS attaches and detaches, PDP address retrieval GPRS Mobile Station class retrieval event reporting, network registration status retrieval, and SMS.

SIM interface pins

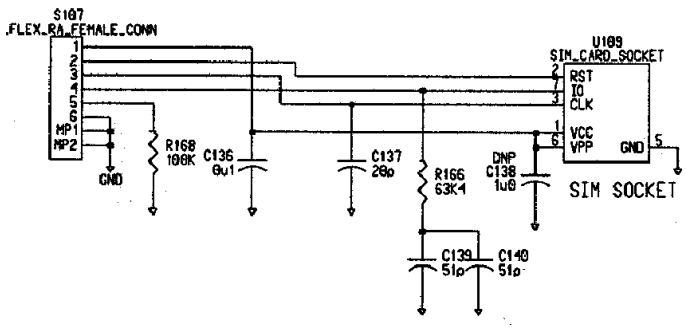
Note: The SIM interface Pins only apply to models with off-board SIM cards.

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 Radio Modem. 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:



SIM test board integration

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.

Serial port

The serial port uses pins 13 and 22 to transmit and receive and may be used only by a custom application that resides on the radio modem itself (not by AT and data traffic). Flow control lines are provided for only the primary serial port.

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	Analog Microphone Input Negative This is an analog input to the radio.
2	MIC P	Analog Microphone Input Positive This is an analog input to the radio.
3	SPK N	Analog Speaker Negative
4	SPK P	Analog Speaker Positive

Pin	Label	Description
5	AGND	Analog Ground This is an analog ground for the radio.
6	COV	Coverage This line is a digital output from the radio. The active state of this line is high and indicates that 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.
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. Refer to "Turning off and turning on the radio" on page 57 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.

Pin	Label	Description
13	RX2	Secondary Receive This line is meaningful only as part of a debug port primarily for RIM internal use.
14	~RI	~Ring Indicate This line is an output from the radio modem. It indicates an incoming call on the serial line. 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..
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	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 deasserted when the radio modem is off. Driving ~DTR low when the radio modem is off will consume unnecessary power.
20	TX	Transmitted data This is an input to the radio. Its idle (no serial transmit activity) state is high. This line is an asynchronous serial input to the radio modem, and should be connected to the host terminal's Transmit Data output. 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 AT+IPR=<rate> AT command.
21	RX	Received data This line is an output from the radio modem. Its idle (no serial receive activity) state is high. This line is an asynchronous serial output from the radio modem, and should be connected to the host terminal's Receive Data input. This line carries data at 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 AT+IPR=<rate> 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 off and turning on the radio

To determine the current state of the radio, observe the ONI line. If ONI is high, the radio is on or is in the process of shutting down. 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. TURNON also enables and disables the serial port.

Turning on the radio

You can turn the radio modem on by setting TURNON to high.

The following considerations are related to turning on the radio:

- During the RIM GPRS Radio Modem's startup procedure, which can take several seconds, all changes to TURNON are ignored by the operating system.
- Do not use TURNON 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, you can turn on the radio by setting TURNON low and then high again.
- 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 off the radio

The RIM GPRS Radio Modem requires a controlled shutdown. You can turn the radio modem off by de-asserting TURNON.

The following considerations are related to turning off the radio:

- During the RIM GPRS Radio Modem's shutdown procedure, which can take several seconds, all changes to TURNON are 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, you can turn off the radio by setting TURNON high and then low again.
- To make sure that power consumption is reduced to the lowest possible levels, all inputs to the radio should be low when the radio is turned off.
- 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 begins shutdown or is turned off.
- It is only necessary to remove power from pins 7 and 8 if the application is very power constrained.

Resetting the Radio

RIM recommends that you 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 may periodically make improvements or optimizations to it. 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 are brought out to an external connector, and a switch is 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) 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
Antenna selection

This section provides information on the following topics:

- Introduction to antenna terminology
- Selecting an antenna
- Antenna requirements
- Antenna design considerations
- Shielding

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 that are described below (refer to page 64).

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 (ERP). For example, if the radio modem delivers 2.0 W of power to a 2.3 dBd gain antenna, the ERP is $2.0 \times 10\text{^}(2^{.3 \div 10}) = 3.4$ 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.

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

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).

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

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 x 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.

Selecting an antenna

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 that you use an experienced antenna provider in order to realize the highest gain possible. A well-designed antenna solution will maximize your application's efficiency, coverage area, and battery life.

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.

An antenna's performance depends on its configuration and environment; the same antenna behaves differently from device to device, even if these devices use the same RIM radio modem. For example, a magmount antenna might be suitable for some applications, because it includes a magnetic base that clamps the antenna 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 antenna system used with the RIM GPRS Radio Modem has the following minimum requirements:

- For 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.
- GPRS, Mobitex, and DataTAC networks have different center frequencies. If the same antenna is used for all three networks, receiver sensitivity is reduced. Contact the RIM OEM Engineering Development team for more information on backward compatibility.
- The RIM GPRS Radio Modem requires an impedance of 50 Ω

Antenna design considerations

Proper antenna positioning maximizes the gain provided by the antenna. When you determine the proper antenna 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

Because the GPRS network is based on a vertically polarized radio-frequency transmission, the application's antenna should be oriented vertically and upward when the radio modem is in use. In small, hand-held devices, a user-friendly design would allow the antenna to be folded out of the way when it is not in use.

Proximity to active electronics

You should position the antenna as far from the computing device's active electronics as possible. Metal construction in a computing device's case and internal components may attenuate the signal in certain directions, which reduces the radio modem's sensitivity and transmit performance 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 when 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

RIM GPRS Radio Modem's electrical design provides high immunity to radio-frequency (RF) noise, also called electromagnetic interference (EMI). The metal casing also acts as a shield that helps to minimize the effect of RF interference that originates in the computing device to which it is attached. The metal casing also prevents 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. In fact, additional RF shielding is less important than making sure that the radio modem's power supply is free of high-frequency electrical noise.

The antenna must be positioned so that the radiated energy is directed away from the computing device. If your application does not permit this positioning, 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 most often affected.

Chapter 8
Certification

This section provides information on the following topics:

- FCC radio frequency exposure rules
- Complying with FCC SAR/MPE guidelines

FCC radio frequency exposure rules

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

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

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

Complying with FCC SAR/MPE guidelines

Antenna

If the RIM GPRS Radio Modem is integrated in a vehicle, and the Eclipse magmount antenna is used, the MPE limits are not exceeded provided that the antenna is installed at least 20 cm from any edge of the vehicle rooftop. This can be accomplished by making it mandatory for customers to put a prominent warning in their user manual, which warns installers to properly mount the antenna in the centre of the vehicle rooftop. The user should also be warned to maintain the minimum required distance from the antenna.

Note: The FCC grant for the RIM GPRS Radio Modem does not limit or restrict it to operating in vehicle-mount configurations. However, in a non-vehicle situation you may need to provide semi-fixed installation procedures for magmount antennas to make sure that the MPE separation distances are met for satisfying grant conditions and to overcome mobility issues caused by such antennas.

Warning: It is mandatory for portable end-products, such as handheld and body-worn devices, to comply with FCC RF radiation requirements' SAR limit.

The submission to the FCC should include end product information, end product SAR/MPE test report, and a reference to the RIM module FCC ID for all other Part22 and 24 requirements.

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

During the SAR/MPE testing, the RIM testing software resides on an external computer that must be able to directly communicate with the radio modem. The device that you submit can meet this requirement one of the following ways:

- The device you submit for testing must have an external connector that can be used to connect the radio modem to a computer.
- If your device can run DOS-based programs, RIM can provide a DOS-based utility that joins two COM ports. This utility is useful if the radio modem might be connected to a handheld device's internal COM 4 port.
- The device has an external RS-232 serial connection to COM 1.
- The device has a virtual link between the two COM ports, so that an external device connected to COM 1 can communicate with the radio modem connected to the internal COM 4, which eliminates the need to remove the radio from the handheld device.

SAR and MPE limits

General Population/ Uncontrolled exposure	1.6 W/kg for partial body exposure, averaged over 1 g of tissue 4 W/kg for hands, wrists and feet averaged over 10 g of tissue **Note:** The 1.6 W/kg limit applies for most RIM radio modems.
Occupational/ Controlled exposure	8 W/kg for partial body 20 W/kg for hands, wrists and feet.
MPE	PCS 1900 MHz band: 1 mW/cm^2 GSM 850 MHz band: 0.56 mW/cm^2

Guidelines

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

Operating manual compliance statement

For mobile and vehicular devices, Integrators should include a statement in their operation, user, and/or installation manual that informs users of RF exposure issues and make sure that bystanders keep a passing distance from the antenna while it

transmits. Integrators should provide instructions or diagrams in the manual for proper antenna mounting and position, when applicable, to make sure that the antenna is 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.

Labelling

Compliance with respect to SAR limits which satisfy MPE limits would not require warning labels, but you can use an RF radiation warning label to alert the user or nearby persons about abnormal usage conditions.

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

For more information

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

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

by searching for “47CFR2.1091” and “47CFR2.1093”.

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

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

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

phone: (202) 418-2464
email: `rfsafety@fcc.gov`
web site: `http://www.fcc.gov/oet/rfsafety`

You can also contact the FCC Call Centre:

phone: 1-888-CALL-FCC (1-888-225-5322)

You can contact the RIM Engineering Development:

phone: (519) 888-7465
email: `oemsupport@rim.net`

Chapter 9
Specifications

This section provides information on the following topics:

- Power supply & typical current usage
- Mechanical & environmental properties

Power supply & typical current usage

Power supply	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

	1902 models	1802 models
Transmit frequency	1850 - 1910 MHz 824 - 829 MHz	1800 MHz 890 - 915 MHz
Transmit power	1.0 W nominal maximum transmit power at antenna port	1.0 W at 1800 MHz 2.0 W at 900 MHz
Receive frequency	1930 - 1990 MHz 869 - 894 MHz	1805 - 1880 MHz 935 - 960 MHz
Receiver sensitivity	typical -107 dBm 2.4% bit error rate (BER)	typical -107 dBm 2.2439% bit error rate (BER)
Multislot Class	8	8

Note: As defined in the GSM specifications, the radio modem's transmitter can reduce output power when it is near a base station.

Serial communications

Serial ports	3.0V asynchronous 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
  - 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	36 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 Flexible Printed Circuit (FPC) connector 6 pin FPC connector (GS models only)
Antenna cable connector	MMCX
Casing	metal
Operating temperature	-30°C to +75°C (at 5-95% relative humidity, non-condensing)
Storage temperature	-40°C to +85°C

Audio

Note: The following audio functionality is not supported:

- automatic gain control (your design should include noise suppression)
- hands free
- echo cancellation

Gain setting

Uplink	0 to 22.5 dB in step of 1.5 dB
Downlink	-36 to 9 dB in step of 1.5 dB

Frequency response (voiceband filter)

	0 -100 Hz	max of -34 dB
	200 Hz	Typ of -1.1
	300 - 3350 Hz	min -0.2 dB max 0.1 dB
	3400 Hz	typ of -0.7 dB
	4000 Hz	typ of -39 dB
	>=4400 Hz	-75 dB
Group delay	500 - 2500Hz	min 300 us max 600 us

Input/output impedance

Input	124 kohm	
Output	minimum	330 ohm (single-ended) 15 ohm (differential)
	maximum	470 pF (single-ended) 100 pF (differential)

Signal to (noise + distortion)

Voiceband ADC	minimum	69 dB (PGA=0dB)
	typical	77 dB
Voiceband DAC	minimum	47 dB (PGA=0dB)

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 61 for more information.

Chapter 10: Glossary

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