RIM OEM Radio Modem for GSM/ GPRS Wireless Networks

RIM 1902G™ and RIM 1802G™

Integrator Guide

Version 1.2

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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
- EU Regulatory Conformance

FCC compliance statement (USA)

FCC Class B Part 15

This section applies to the RIM OEM Radio Modem for GSM/GPRS Wireless Networks (R6420GN).

The 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 section applies to the RIM OEM Radio Modem for GSM/GPRS Wireless Networks (R6420GN).

The device complies with Industry Canada RSS 133, under certification number 2503A-R6420GN.

Class B compliance

The RIM OEM Radio Modem for GSM/GPRS Wireless Networks 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.

EU Regulatory Conformance

This section applies to the RIM 1802G™ OEM Radio Modem for GSM/GPRS Wireless Networks (R6420GE).

Research In Motion Limited hereby declares that the device is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

CE0168

The original Declaration of Conformity made under Directive 1999/5/EC is available for viewing at the following location in the EU community:

Research In Motion UK Limited
36 Station Road, Egham, Surrey
TW20 9LF
United Kingdom

Contents

About this guide

This guide explains how to integrate the RIM OEM Radio Modem for GSM/GPRS Wireless Networks 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 with the RIM radio modem
- antenna selection and placement

This guide provides suggestions and precautions to 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 includes the *AT Command Reference Guide*, which lists the AT commands that apply to the RIM 1902G and RIM 1802G radio modems.

Chapter 1
The RIM OEM Radio Modem for GSM/GPRS Wireless Networks

This section provides information on the following topics:

- GPRS network technology
- About the RIM 1902G and RIM 1802G radio modems

GPRS network technology

The Global System for Mobile Communication (GSM) 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 technology enables 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/GSM networks are deployed worldwide. 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.

About the RIM 1902G and RIM 1802G radio modems

The RIM OEM Radio Modem for GSM/GPRS Wireless Networks sets a new standard for radio modem performance. The radio modem's 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 allowable download rates using a single receiver on a GPRS network.

The RIM OEM Radio Modem for GSM/GPRS Wireless Networks consists of the following models:

- RIM 1902G™
- RIM 1802G™

Model	Description
RIM 1902G™	This model is designed for use with GPRS and GSM wide-area wireless voice and data networks operating in the 1900 MHZ and 850 MHz range in North America. The off-board SIM card configuration has a 6-pin ZIF connection that enables you to position the SIM card in the location that best suits your design. A configuration with an on-board SIM card is also available.
RIM 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 outside of North America. The off-board SIM configuration has a 6-pin ZIF connection, which allows you to position the SIM card in the location that best suits your design. A configuration with an on-board SIM card is also available.

The RIM 1902G and RIM 1802G offer the following features:

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

These benefits of these features are described below.

Range of applications

RIM radio modems are designed to integrate easily into computing devices for a wide range of applications, such as the following ones:

- laptop computers
- vehicle tracking
- point-of-sale devices
- monitoring and telemetry applications
- ruggedized terminals
- vending machines
- handheld computers
- utility meters
- parking meters
- billboards
- dispatching applications
- 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 1902G and RIM 1802G typically have receiver sensitivities of -107 dBm with a 2.2439% bit error rate (BER).

Note: BER is an industry standard error rate that is used to define sensitivity; it does not indicate that 2.2439% of the data that is passed by the radio to the application is corrupted.

Noise immunity

The RIM 1902G and RIM 1802G are not desensitized by the electromagnetic interference (EMI) or "noise" that is generated by the electronics of the terminal into which it is integrated. As a result, no special shielding is required between the radio and your device.

Noise immunity offers several key benefits:

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

Powerful and efficient transmitter

When necessary, the RIM 1902G can supply a full 1 watt at 1900 MHz and 0.8 watts at 850 MHz. The RIM 1802G can supply a full 1 watt at 1800 MHz and 2 watts at 900 MHz. The RIM 1902G and RIM 1802G quickly decrease 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 1902G and RIM 1802G conserve battery power and provide a balanced link.

The RIM OEM Radio Modem for GSM/GPRS Wireless Networks provides reliable transmission efficiency across the entire operating voltage range of 3.5 to 4.75 volts. As a result, batteries can be used even when they are near depletion. The transmission efficiency also maximizes the radio coverage area throughout the life of the battery.

Small size

Because of its single board design, the RIM OEM Radio Modem for GSM/GPRS Wireless Networks is very thin and, at only 42.0-by-67.5 mm, is smaller than a business card. This small size enables the radio modem to meet most applications' tight space requirements. The radio modem's single-board design is more reliable than multiboard designs, particularly in high-vibration environments (such as vehicles) or in devices that can be dropped (such as handheld devices).

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 the integration of the RIM OEM Radio Modem for GSM/GPRS Wireless Networks. RIM provides works closely with partners to evaluate the feasibility of implementing a wireless communication solution and 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.

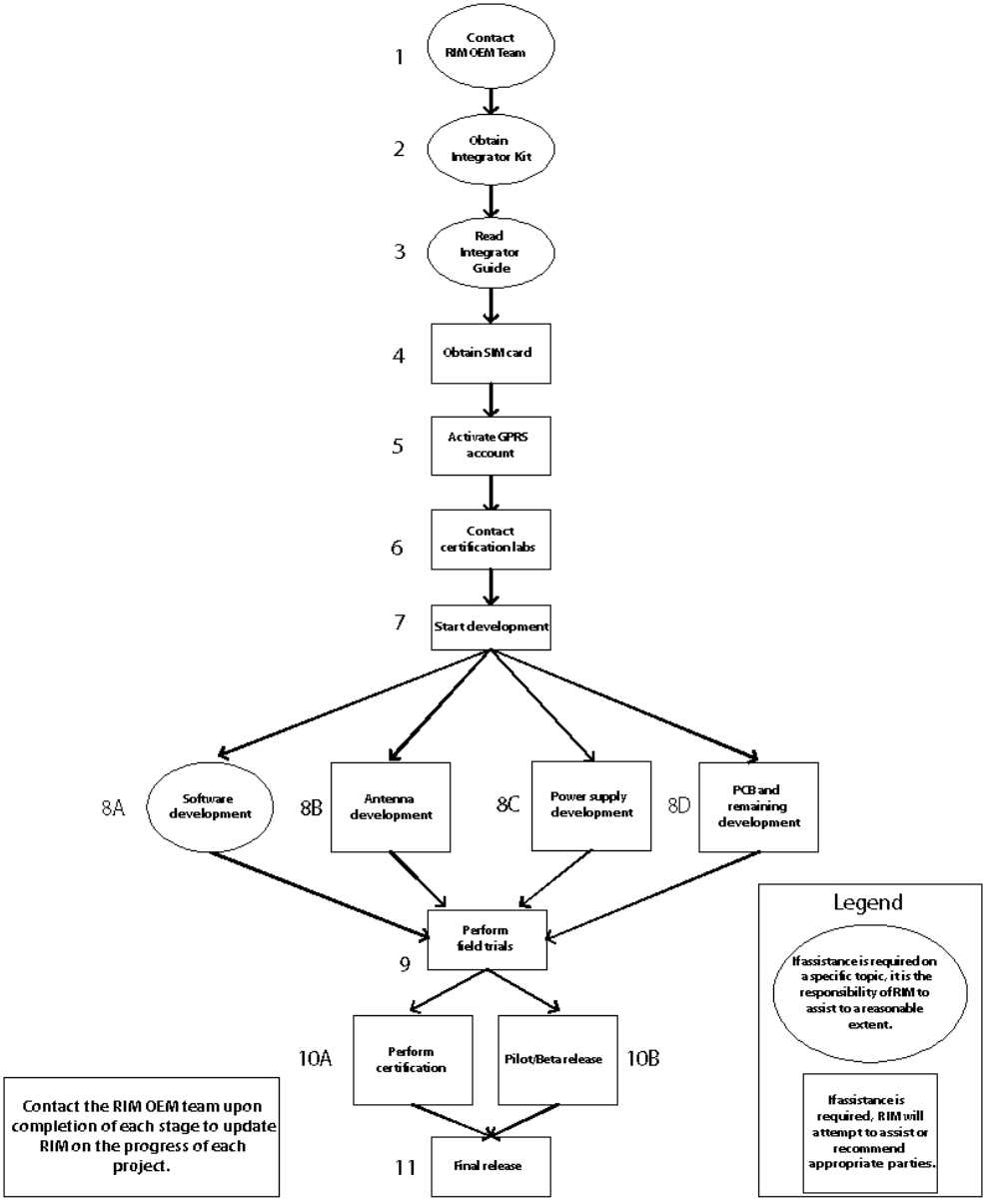
Working with RIM

RIM has an experienced team to help you design and implement your wireless communication solutions. 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: (519) 888-7465 ext. 5200
Fax: (519) 883-4940
Email: oemsupport@rim.net
Web site: http://www.rim.net/oem

Integration overview

The following diagram illustrates the integration process.



The following table describes each step in the integration process. For more information, contact RIM at oemsupport@rim.net or visit http://www.rim.net/oem.

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, and antenna selection and placement.
Obtain SIM card	Contact the appropriate network provider to obtain a SIM card.
Activate GPRS account	Contact the appropriate network provider to activate the GPRS account.
Contact certification labs	Learn about obtaining certification. Radio frequency (RF) emitting products cannot be sold 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.
Start development	Plan your project carefully before you start development. You must address several important considerations when you plan your design. To speed up the development process, you can often perform several procedures simultaneously.
Develop software	Contact RIM if you encounter any problems with the communication between the off-board 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 OEM Radio Modem for GSM/GPRS Wireless Networks. If this antenna does not meet your needs, develop an antenna for use with the final product. Refer to the *Integrator Guide* for guidelines on selecting an antenna. You can also contact RIM for general assistance and for recommendations of antenna companies that can provide further assistance.

Step	Description
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.
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 assess performance and reliability.
Perform certification	Choose a testing lab to perform appropriate certification: • For RIM 1902G: FCC, Industry Canada, and PTCRB • For RIM 1802G: R&TTE and GCF
Pilot/Beta release	Contact RIM prior to the 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 confirm that the release conforms to legal requirements.
Final release	Contact RIM if you encounter any obstacles related to the RIM OEM Radio Modem for GSM/GPRS Wireless Networks. Provide RIM with regular updates on the progress of the release.

Chapter 3
Setting up the Interface and Test Board

This section provides information on the following topics:

- Interface and Test Board components
- Setting up the Interface and Test Board (on-board SIM configuration)
- Setting up the Interface and Test Board (off-board SIM configuration)

Interface and Test Board components

The RIM Interface and Test Board provides a standard RS-232 serial interface between a computer and the radio modem. The Interface and Test Board enables you to connect the RIM OEM Radio Modem for GSM/GPRS Wireless Networks to a standard computer using a COM port or to a terminal device using a RS-232 serial port. The Interface and 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 Interface and 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 jacks
- FPC cable connector

The following table describes Interface and Test Board components.

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 OEM Radio Modem for GSM/GPRS Wireless Networks, which is typically integrated into a device that operates an asynchronous serial port at 3V. The RS-232 interface on the Interface and Test Board enables 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 Interface and Test Board. When the switch is off, the radio turns off. Refer to "Turning on and turning off the radio" on page 57 for more information.
Test points	The Interface and 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 indicates real-time data flow.

Component	Description
Power supply	The RIM OEM Radio Modem for GSM/GPRS Wireless Networks 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 of the Interface and Test Board.
LED indicators	The Interface and Test Board includes LED indicators to indicate the flow of data to and from the host (in real time), the radio power status, power to the Interface and Test Board, network coverage, and more.
Standard SIM card holder	The Interface and Test Board includes a SIM card holder for use with standard 3V or 5V SIM cards. The SIM card is necessary to access GSM/GPRS networks.
Microphone/speaker jacks	The Interface and Test Board includes microphone and speaker jacks for use with the headset that is included in the Integrator Kit. The microphone and speaker jacks enable you to use the GSM circuit-switched voice network that underlies the GPRS networks.
FPC cable connector	The flexible printed circuit (FPC) cable connector is used to connect the 22-pin FPC cable to the Interface and Test Board.

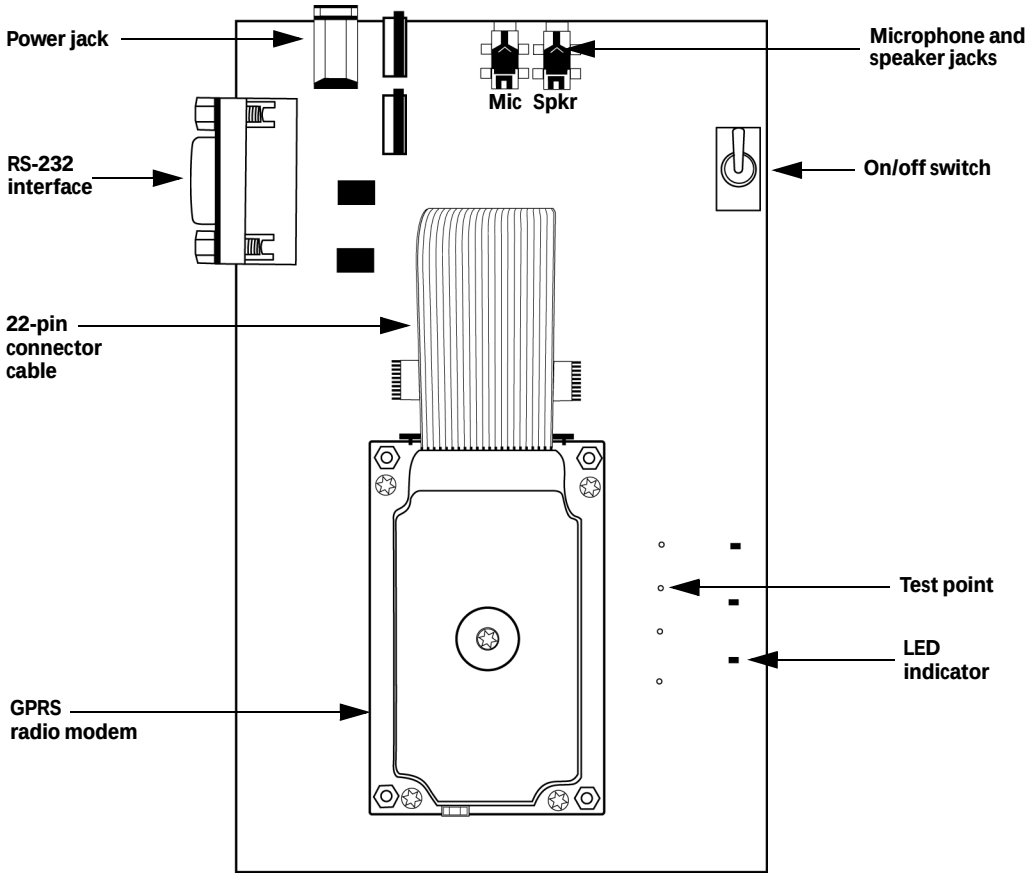
Setting up the on-board SIM configuration

To use the Interface and Test Board that is provided with your Integrator Kit, you must connect the RIM 1902G or RIM 1802G to an antenna, SIM card, and a computer (or another device with a RS-232 serial interface). Use the Interface and Test Board and cables that are supplied with your Integrator Kit.

To set up the Interface and Test Board, complete the following steps:

1. Connect the radio modem to the Interface and Test Board.
2. Connect the Interface and 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 Interface and Test Board to an AC outlet.
6. Turn on the system.
7. Connect the headset.

The following diagram illustrates the Interface and Test Board and major components for the on-board SIM card configuration.



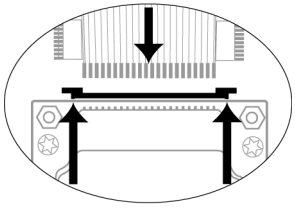
Interface and Test Board for on-board configuration – top view

To connect the radio modem to the Interface and Test Board

Note: This step is only necessary if the radio modem is not already connected to the Interface and 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 Interface and 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 Interface and 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 Interface and Test Board.

To connect the Interface and Test Board to the computer

Use the straight-through DB-9 serial cable to connect the Interface and Test Board to the computer.

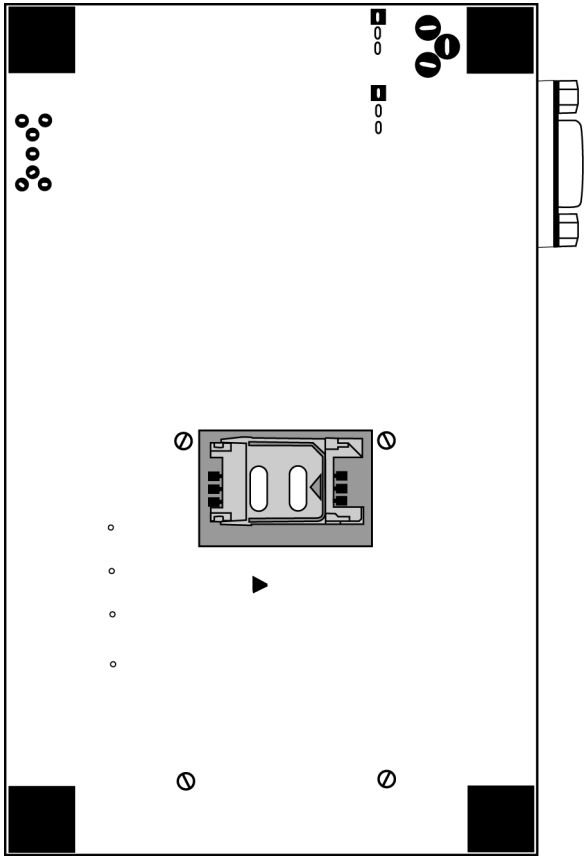
Connect the male end of the cable to the Interface and Test Board. Connect the female end of the cable to an available COM port on the computer.

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.

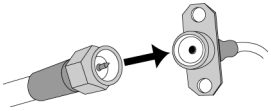
3. Slide the SIM card into the cover with the conductive side facing the leads on the board. The notched end of the SIM card should align with the notch in the SIM card holder.
4. Close the cover. Slide the cover in the reverse direction of the arrow to lock it into place.

To connect the antenna to the radio modem

Note: If you connect the antenna before you connect the Interface and Test Board to an AC outlet, the radio modem detects network coverage more reliably.

The Integrator Kit includes a high-performance, 3 dBd-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 fastened securely.



Connecting the SMA cable to the 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 Interface and Test Board to an AC outlet

Plug the 5V DC, 2.4A, center-pin-positive power adapter into an electrical outlet. Connect the other end to the Interface and Test Board's power jack.

To turn on the system

Move the power switch to the `TURNON` position.

When the radio is on, the LED marked `ONI` is lit. Refer to "Turning on and turning off the radio" on page 57 for more information.

To connect the headset

1. Insert the microphone plug into the microphone jack.
2. Insert the speaker plug into the speaker jack.

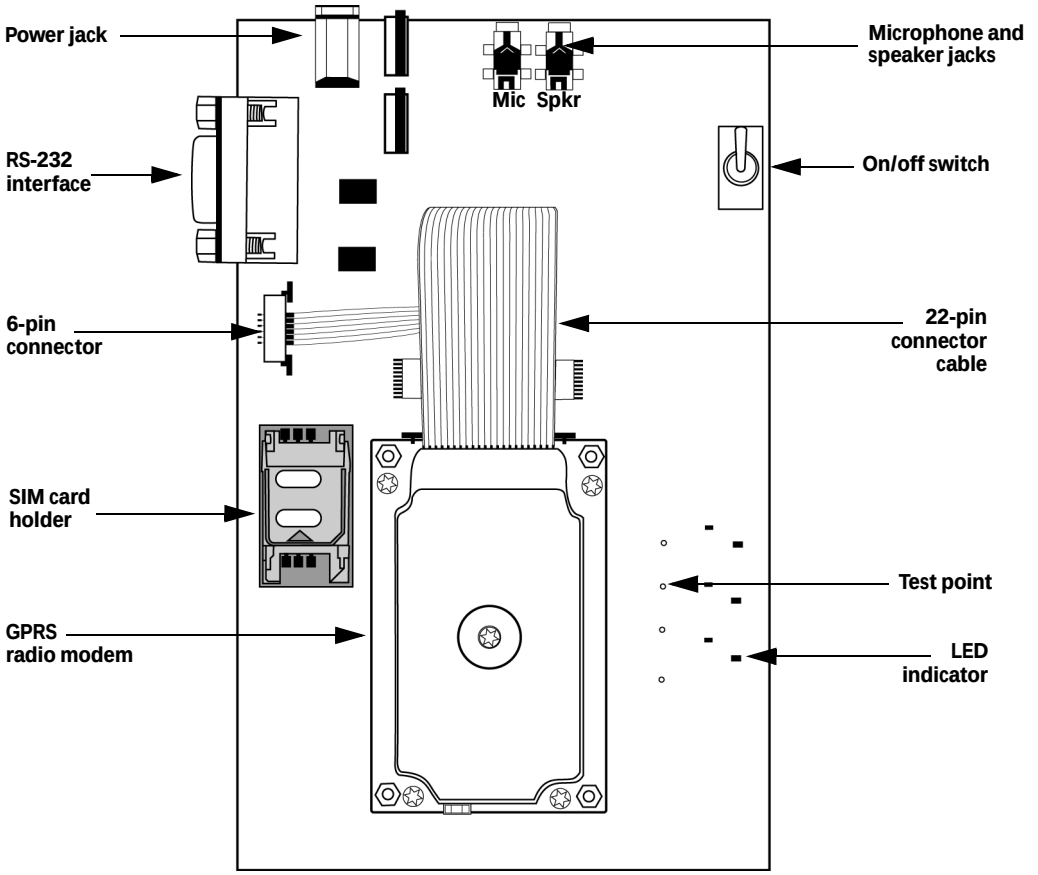
Setting up the off-board SIM configuration

To use the Interface and Test Board that is provided with your Integrator Kit, you must connect the RIM OEM Radio Modem for GSM/GPRS Wireless Networks to an antenna, SIM card, and computer (or another device with a RS-232 serial interface). Use the Interface and Test Board and cables that are supplied with your Integrator Kit.

To set up the Interface and Test Board, complete the following steps:

1. Connect the SIM card to the Interface and Test Board.
2. Connect the radio modem to the Interface and Test Board.
3. Connect the Interface and 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 Interface and Test Board to an AC outlet.
7. Turn on the system.
8. Connect the headset.

The following diagram illustrates the Interface and Test Board and major components for the off-board SIM configuration.



Interface and Test Board for off-board configuration— top view

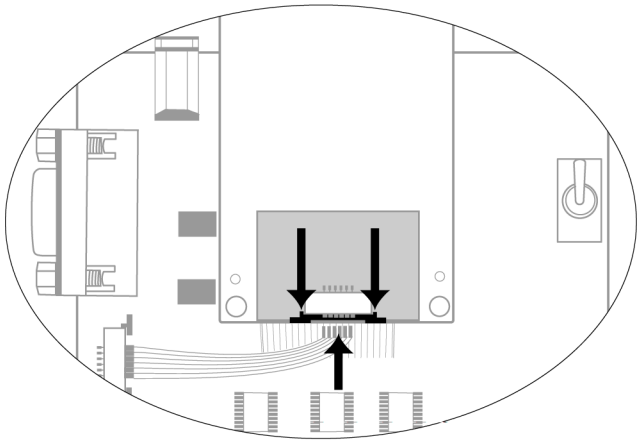
To connect the SIM card to the Interface and Test Board

Note: This task only applies to the off-board SIM configuration.

The 6-pin flat SIM interface cable carries the data and power between the Interface and Test Board SIM slot and the radio modem.

1. Remove the radio modem from the Interface and Test Board: unfasten the nuts and lift the radio modem up and away from the Interface and 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 Interface and 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.

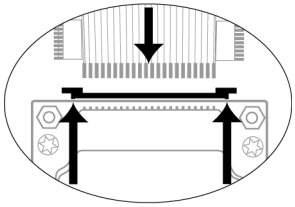
4. Push the black tabs down toward the connector to secure the cable.
5. Repeat steps 2 through 4 to connect the 6-pin connector to the Interface and Test Board.
6. Re-attach the radio modem to the Interface and Test Board.

To connect the radio modem to the Interface and Test Board

Note: This step is only necessary if the radio modem is not already connected to the Interface and 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 Interface and 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 Interface and 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 Interface and Test Board.

To connect the Interface and Test Board to the computer

Use the straight-through DB-9 serial cable to connect the Interface and Test Board to the computer.

Connect the male end of the cable to the Interface and 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 APN that will be targeted.

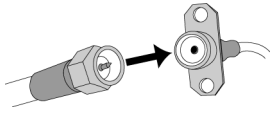
1. Slide the SIM card holder in the direction of the arrow to unlock it, and then lift the cover open.
2. Slide the SIM card into the cover with the conductive side facing the leads on the board. The notched end of the SIM card should align with the notch in the SIM card holder.
3. Close the cover, and 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 Interface and Test Board to an AC outlet, the radio modem 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 fastened securely.



Connecting the SMA cable to the 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 Interface and Test Board to an AC outlet

Plug the 5V DC, 2.4A, center-pin-positive power adapter into an electrical outlet. Connect the other end to the Interface and Test Board's power jack.

To turn on the system

Move 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 on and turning off the radio" on page 57 for more information.

To connect the headset

1. Insert the microphone plug into the microphone jack.
2. Insert the speaker plug into the speaker jack.

Chapter 4
Integrating the RIM OEM Radio Modem for GSM/ GPRS Wireless Networks

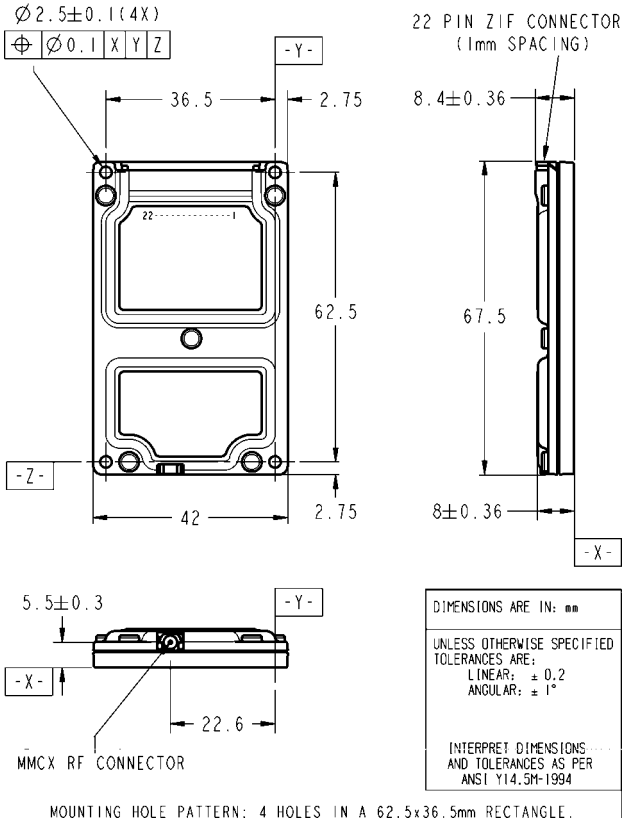
This section provides information on the following topics:

- 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 application. These components consist of two 22-pin connector cables, two 6-pin connector cables (off-board SIM configuration), and two radio modem mechanical samples.



Mechanical diagram of GPRS OEM radio modem

Refer to "Specifications" on page 65 for more information on mechanical and environmental properties.

Mounting methods

RIM OEM Radio Modem for GSM/GPRS Wireless Networks 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 in which it is used.

This section describes the following mounting methods:

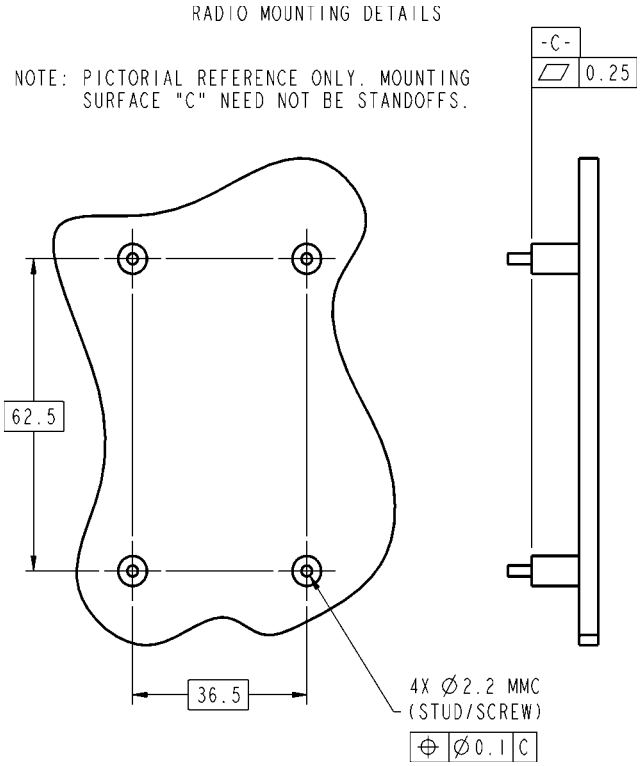
- bolts or standoffs
- tie wraps
- permanent industrial adhesive

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.



Radio mounting details

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 surface.

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 circuit components inside the radio.

Permanent industrial adhesive

The RIM OEM Radio Modem for GSM/GPRS Wireless Networks 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 that is used in the radio modem's outer casing and the surface to which the radio modem will be mounted. The RIM OEM Radio Modem for GSM/GPRS Wireless Networks'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 (off-board SIM configuration)
- 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 might need to create a custom flat flex cable (FFC) jumper that has the correct length and correct connector orientation for your application. Refer to the following diagram for more information.

Note: The interface cable that is 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. Contact RIM at `oemsupport@rim.net` for help with selecting an appropriate connector for your application.

SIM interface cable and connector

Note: The SIM interface cable and connector are required for the off-board SIM card configuration only.

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-mm centerline spacing that can plug into a matching connector.

Because each application is unique, you might need to create a custom FFC jumper that has the correct length and connector orientation for your application.

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-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 available. Contact RIM at `oemsupport@rim.net` for help with selecting an appropriate connector for your application.

Antenna cable and connectors

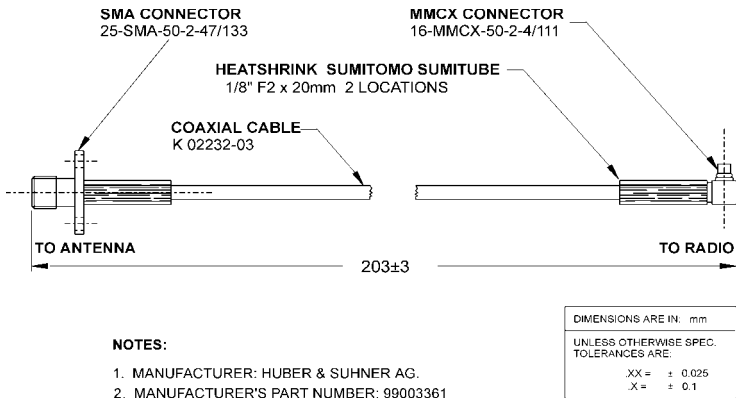
The antenna cable and connector connects the antenna to the radio modem. RIM uses the industry-standard MMCX connector for the RIM OEM Radio Modem for GSM/GPRS Wireless Networks. The MMCX connector is very small, and it has the mating force to withstand heavy vibration.

Typically, an antenna does not plug directly into a RIM 1902G or RIM 1802G. Instead, a cable is used between the radio's antenna connector and a second connector at the device's outer casing. This enables 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 Ohm, and an MMCX plug that mates with the RIM 1902G or RIM 1802G MMCX jack. The other end of the cable can be any connector with an impedance of 50 Ohm. 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 1902G or RIM 1802G.

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 (50W) cable
133REEZ4-12-S2/1216	8″ cable, straight MMCX to SMA
133REEZ4-12-S2/1699	8″ cable, right-angle MMCX to SMA

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 1902G or RIM 1802G draw their power in bursts; the power required changes rapidly depending on whether the radio is transmitting, receiving, or idle.

Power supply parameters

The RIM 1902G or RIM 1802G requires a clean, stable 3.5 to 4.75 volt source that is capable of delivering a 577us burst every 4.616 ms of up to 1.2 A (for the RIM 1902G) or 2.0 A (for the RIM 1802G) 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 compatible with the RIM 902M™ and RIM 802D™ radio modems, make sure that the power input to the radio modem is above 4.1 V. Contact the RIM OEM Integration Specialist team for further details on backwards compatibility.

Ripple specification

For best performance, RIM recommends a 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 the 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 3.5V to the radio modem at 2.2 A.

Power requirements

The RIM 1902G or RIM 1802G 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 1902G or RIM 1802G 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 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. Battery specifications should be obtained from the manufacturer.

The cells that you use must meet the radio modem load specifications (refer to page 46); for transmission, they must provide 1.2 A (RIM 1902G) or 2.0 A (for the RIM 1802G) at 4.2V. 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 5 to 10 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 might 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 be able to recharge only a few times 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. 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 110V or 220V) 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 load limits of the radio modem, you can add zener diodes or other spike arrestor circuits for transient voltage protection. These should have a value of 20V and be placed on the supply side of the regulator circuit. Refer to "Load specifications" on page 46 for more information.

Automotive supplies

If you plan to power the RIM 1902G or RIM 1802G 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 can be as high as 70V, especially on startup. Commercial automotive adapters are available that safely convert the 12V automotive supply to a regulated supply suitable for operating the radio modem.

Chapter 6
Interface specification

This section provides information on the following topics:

- RIM 1902G or RIM 1802G interface
- AT Commands
- SIM interface pins
- Radio interface pins
- Turning on and turning off the radio
- Loading firmware (optional)

RIM 1902G or RIM 1802G interface

The asynchronous serial interface on the RIM 1902G or RIM 1802G operates at 3V, 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 1902G or RIM 1802G can be connected directly to a microcontroller, or through a Universal Asynchronous Receiver/Transmitter (UART) to a microprocessor data bus. If the radio modem is connected directly to a computer or other RS-232 device, an interface must be provided to convert the signal voltage to the higher values required.

The RIM 1902G or RIM 1802G is compliant with GSM Phase 2/2+ specifications. For detailed information on the AT command structure, refer to the *AT Command Reference Guide*, which is 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 redialing.
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 operations related to short message service (SMS) and and cell broadcast service (CBS) for both text and protocol data unit (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 for GPRS attaches and detaches, PDP address retrieval, GPRS mobile station class retrieval, event reporting, network registration status retrieval, and SMS.

SIM interface pins

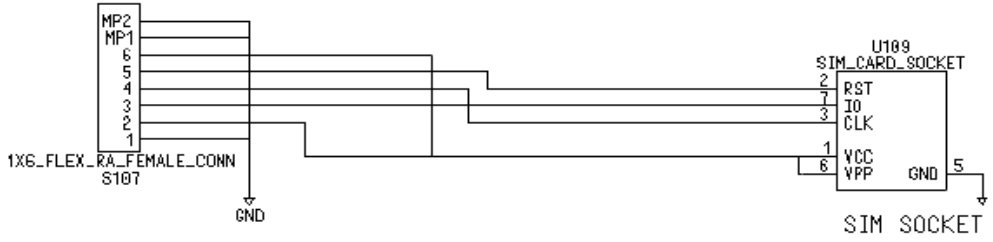
Note: The SIM interface pins only appear on models with off-board SIM cards.

This section describes the purpose of each of the 6 lines that comprise the SIM interface to the RIM 1902G or RIM 1802G, with the off-board SIM card configuration. All SIM interface lines are 3V. The RIM 1902G or RIM 1802G software polls the SIM card to confirm its presence.

Note: For proper operation, the SIM connector cable should be no more than 10 cm 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 card with power. Verify that it leads to the VCC pin of the SIM card connector. It might be necessary to filter noise on the line to prevent a fault from occurring. Refer to the following diagram for 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 two-way line between the SIM card connector and the RIM 1902G or RIM 1802G. 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 so that 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 Interface and Test Board:



SIM Interface and 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 OEM Radio Modem for GSM/GPRS Wireless Networks.

Pins 1 to 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 to 22

Input and output lines from pins 5 to 22 are 3V; however, they can also drive 3.3V systems.

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

Serial port

The serial port uses pins 20 and 21 to transmit and receive AT commands and data between the radio modem and the computing device.

Pin descriptions

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

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
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. An AT command is available to change the function of this pin, causing it to be asserted high when the radio is GPRS-attached.
7, 8	—	Power supply These pins supply power to the radio. Because 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 enables the radio to turn on.
9	GND	Ground This line should be tied to the system ground of the computing device for proper operation. Pin 18 should also be connected to a grounded source.
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 3V input to the radio, and is not 5V tolerant. Refer to "Turning on and turning off the radio" on page 57 for more information.

Pin	Label	Description
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, the unit is ready to receive data, but if CTS is low and ONI is low, 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 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	TX2	Secondary Transmit This line is an input to the radio modem (for RIM internal use only).
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 1902G or RIM 1802G may be lost. This line is a flow control mechanism that is normally reacted to by the UART in your serial communication system. If you do not plan to use it, leave ~CTS disconnected.

Pin	Label	Description
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. Pin 9 should also be connected to ground.
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. Deasserting ~DTR also reduces power consumption significantly even with the radio on. If you do not intend to use ~DTR, tie it to ground so 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 consumes unnecessary power.

Pin	Label	Description
20	TX	Transmitted data This is an input to the radio modem. Its idle (no serial transmit activity) state is high. This line is an asynchronous serial input to the radio modem, and should be connected to the host terminal's transmit data output. This line carries data at a maximum of 115 200 bps. 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 bps. Parameters are 8 bits, No parity, 1 stop bit. The baud rate can be changed using the AT+IPR=<rate> AT command.
22	RX2	Secondary Receive This line is an output from the radio modem (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 on and turning off 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 turning 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.

Turning on the radio

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

During the radio modem's startup procedure, which can take several seconds, all changes to TURNON are ignored by the operating system. If the radio fails to respond to a high TURNON line, the radio might require service or the power supplied to the radio might be too low for proper operation.

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.

Turning off the radio

The RIM 1902G or RIM 1802G requires a controlled shutdown. You can turn the radio modem off by de-asserting `TURNON`.

Data that has been received by the radio modem from the network, but has not been transferred to the computing device, is not saved. The data is discarded when the radio modem turns off.

When the radio modem turns off, which can take several seconds, all changes to `TURNON` are ignored by the operating system. To make sure that power consumption is reduced to the lowest possible levels and sleep mode is achieved, all inputs to the radio should be inactive when the radio is turned off. In particular, pin 19 (~DTR) should be inactive (3V).

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.

If the application is very power constrained, you only need to remove power from pins 7 and 8.

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 enables 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 might 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 are always able to communicate with each other, and with the same fixed servers, through the wireless network. Nevertheless, you might 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 wirelessly. 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 based on a command prompt, the programming utility must reside on a computer 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 RIM highly recommends that this be incorporated into at least one device that is designated for testing purposes.

Chapter 7
Antenna selection

This section provides information on the following topics:

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

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 62).

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 very high frequency (VHF) and ultra high frequency (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 1902G or RIM 1802G can be as high as 1W at 1900 MHz and 1800 MHz, 0.8W at 850 MHz, or 2W at900 MHz. 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 2W of power to a 2.3 dBd gain antenna, the ERP is 2.0 × 10^((2.3 ÷ 10) = 3.4W, 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 1902G or RIM 1802G is 50 ohm, which is a widely available industry standard. Any deviation from this value might 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 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.

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

Return Loss equation

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).

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

VSWR equation

VSWR = 1 or RL = -∞ dB is a perfect match. In practice, imperfections are inevitable, which means that VSWR is greater than 1 and RL is 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 1902G or RIM 1802G 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 reduces 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 proper antenna maximizes the coverage area of the RIM 1902G or RIM 1802G.

The antenna that you choose should suit your project's needs. There are many different antenna types and options that can meet your engineering and user requirements and remain within budget constraints. RIM strongly recommends that you use an experienced antenna provider to realize the highest gain possible. A well-designed antenna solution can 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 that operate 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 that is used with the RIM 1902G or RIM 1802G has the following minimum requirements:

- For the RIM 1902G or RIM 1802G 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 Integration Specialist team for more information on backward compatibility.
- The RIM 1902G or RIM 1802G requires an impedance of 50 ohm.

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

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, handheld devices, a user-friendly design enables 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 oriented in certain ways. Using metal in the construction of a ground plane for an antenna can significantly improve the antenna gain and the system's coverage.

Transmission interference

To prevent interference from the antenna into the radio modem during transmission, the antenna must be placed a minimum of 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 handheld 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 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 ohms. You must use a proper matching connector, because each connector in the signal path introduces a return loss and reduces performance.

Shielding

The RIM 1902G or RIM 1802G 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 1902G or RIM 1802G 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 might 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 might need to be shielded. Circuits such as cathode ray tubes (CRTs) and LCD display drivers are most often affected.

Chapter 8
Specifications

This section provides information on the following topics:

- Power supply and typical current usage
- RF properties
- Serial communications
- Mechanical and environmental properties
- Audio
- Gain setting
- Frequency response (voiceband filter)
- Input/output impedance
- Signal to (noise + distortion) ratio

Power supply and typical current usage

Power supply	single power supply
Operating range	3.5 to 4.75V DC
Transmit mode	up to 2.2A (at 4.2V, output 1W)

RF properties

	RIM 1902G	RIM 1802G
Transmit frequency	1850 - 1910 MHz 824 - 849 MHz	1710 - 1785 MHz 880 - 915 MHz
Transmit power	1W at 1900 MHz 0.8W at 850 MHz	1W at 1800 MHz 2W at 900 MHz
Receive frequency	1930 - 1990 MHz 869 - 894 MHz	1805 - 1880 MHz 925 - 960 MHz
Receiver sensitivity	-107 dBm (typically) 2.2439% BER	-107 dBm (typically) 2.2439% 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	3V asynchronous
Link speed	1200 to 115 200 bps

Mechanical and environmental properties

Weight	36 g (1.23 oz), including case
Dimensions	42.0 by 67.5 mm (1.65" x 2.66")
Thickness	8.4 mm (.33")
3V interface connectors	22 pin Flexible Printed Circuit (FPC) connector 6 pin FPC connector (on-board SIM configuration only)
Antenna cable connector	MMCX
Casing	metal
Recommended operating temperature	-30°C to +75°C (at 5-95% relative humidity, non-condensing)
Recommended storage temperature	-40°C to +85°C

Audio

The radio modem does not support the following functionality:

- automatic gain control (your design should include noise suppression)
- hands-free operation
- 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 µ max 600 µ

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) ratio

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

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