Integrator's
Guide

RIM 801D
OEM Radio Modem

version 1.0

RIM 801D OEM Radio Modem Integrator's Guide
Last Revised: 22 February 1999

Part Number: MAT-01769-002 Rev. 001

Research In Motion

295 Phillip Street
Waterloo, Ontario
Canada N2L 3W8
tel. (519) 888-7465
fax (519) 888-6906

Internet: info@rim.net
Web site: www.rim.net

DATATAC Interface, specified DataTAC Open Protocol Specification 970.0775R1

Printed in Canada AM0598R801D-int

FCC Compliance Statement (USA)

FCC Class B Part 15

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

1. This device may not cause harmful interference, and

2. This device must accept any interference received, including interference that may cause undesired operation.

Warning

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the manufacturer's instructions, may cause harmful interference to radio communications.

There is no guarantee, however, that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

Contents

Figures, tables and equations

About this guide

This document is a guide to integrating the RIM 801D OEM DataTAC radio modem into an embedded system, such as a laptop computer, PDA, vending machine, POS terminal, or alarm system.

Topics covered in this guide include:

- physical size and mounting requirements
- power and battery characteristics
- interfacing to the RIM 801D
- antenna selection and placement
- communication protocols

Throughout the guide, there are suggestions and precautions that will ease the implementation of a wireless communication solution. Attention is drawn to these through the use of the two symbols below.

This symbol represents a hint or a suggestion. Although the ideas presented are *not necessary* to the integration of the RIM 801D, they are useful to many applications, and they may save integrators time.

This is an important note or a warning. The text will advize integrators of a potentially hazardous situation, or a *necessary* precaution to take when designing applications.

1

Introduction

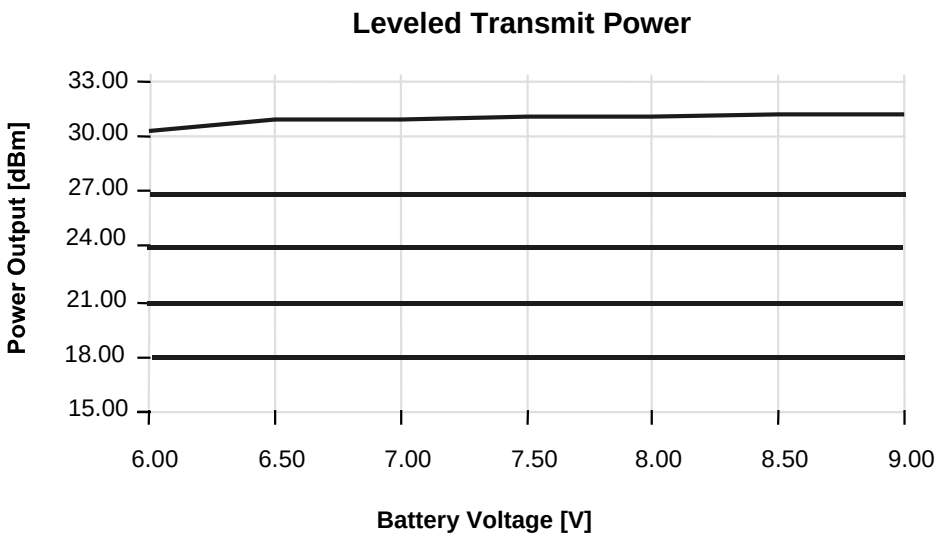
Topics covered in this introduction include the RIM 801D OEM radio modem features and an introduction to DataTAC network technology.

Radio modem features

The RIM 801D OEM radio modem is specifically designed to integrate easily into a computer or other embedded system, such as PDAs, vending machines, and point-of-sale terminals. Operating in the 800 MHz frequency range, the RIM 801D is compatible with DataTAC wide-area wireless data communication networks.

Powerful and efficient transmitter

The RIM 801D provides reliable transmit efficiency throughout the range of operational voltage (6.0 to 9.5 volts). This is an important feature because the radio modem does not lose transmit power as battery voltage drops, thereby keeping the radio coverage area at a maximum throughout the life of the battery. The chart below shows how the transmit power output remains constant over the 6.0 to 9.5 volt supply.



Noise immunity

The RIM 801D is not de-sensitized by RF noise generated by nearby electronics. This makes the RIM 801D ideal for integration into hand-held terminals, and eliminates the need for special shielding. Noise immunity significantly increases reliability, improves performance, extends battery life, and increases the effective range of operation of the RIM 801D.

Low power requirements

Battery life is a critical issue for portable devices: end-users want long lasting devices without heavy battery packs. The RIM 801D sets a new power consumption standard for OEM-style radio modems by reducing standby power to only 12 mA. This allows the RIM 801D to maximize efficiency and ensure long battery life.

Small size

Using a single board design, the RIM 801D is very thin, only 0.3” to 0.38” (7.5 to 9.6 mm). The RIM 801D is about the size of a credit card, with a footprint of 3.5” by 2.6” (87.5 by 66.3 mm). This tiny size makes the RIM 801D very lightweight (only 2.3oz or 64g, including case) and allows the device to meet tight space requirements within most applications.

DataTAC network technology

The DataTAC infrastructure has become an international data communications standard, offering fast data transmission rates with accurate, highly reliable message delivery. DataTAC networks are deployed around the world from North America to Europe to Asia-Pacific.

Using an advanced Radio Data Link Access Procedure (RD-LAP) radio channel protocol, DataTAC systems provide transmission rates up to 19.2 kb per second and 9.6 kb per second depending on the country. Those rates mean fewer delays and faster response times for the mobile user. For network operators, they mean greater capacity to accommodate more customers, while minimizing the required investment in network infrastructure.

DataTAC's error detection and correction schemes provide increased message accuracy, fewer message retries and enhanced networks throughput. With DataTAC technology, the state of the entire network is constantly monitored and safety mechanisms including system alarms, remote diagnostics and redundant back-up links ensure network reliability and availability.

The key components of the network infrastructure include the Network Management Center (NMC), Area Communications Controller (ACC) and base site equipment.

The NMC is an advanced client-server based management tool which provides all network administration, operation and maintenance functions. It acts as the central point of control in the DataTAC system.

The ACC consists of the Radio Network Gateway (RNG), Radio Network Controller (RNC), and Communications Hub. The ACC is primarily responsible for all message switching and routing functions, as well as providing the key communication link between host computers and remote base stations. Connectivity between the host computer and the infrastructure is established using industry standard X.25 or TCP/IP host link protocols. The ACC maintains all customer-specific information for each device on the system and allows users within a given geographic area to connect to host application services. It manages user device authorization, roaming control and base site control. It also collects all system usage/traffic information for accounting/billing purposes and detailed analysis of usage patterns.

DataTAC Data System Station (DSS) base site equipment is located at various remote sites in the operational area of coverage and provides the RF link between the DataTAC infrastructure and end user devices. They convert the host data messages into the RD-LAP radio channel protocol for transmission to the user devices and reverse the process on the return connection. They also allow device roaming between base site coverage areas in a seamless manner completely transparent to the end user.

2

Mechanical specifications and mounting needs

This chapter provides information about the RIM 801D that will be useful in determining the physical positioning of the radio modem within an application. Environmental properties, case dimensions, cabling, connectors, and mounting suggestions are presented.

Environmental properties

The RIM 801D OEM Radio Modem is designed to function within the following environmental limits:

- -30°C to +55°C (-22°F to +131°F) operational
- -40°C to +85°C (-40°F to +185°F) storage
- 5 to 95% relative humidity, non-condensing

Physical properties

Dimensions

The RIM 801D has been designed to meet the most stringent space requirements. In most cases, there will be sufficient room in an existing enclosure to house the radio modem. Within the case of the modem, the smaller components are mounted on one side, and the larger components on the other. This separation of large and small components results in a case with two different thickness (see Figure 2, below).

The overall maximum dimensions of the radio modem are:

- Width: 2.61” (6.63 cm)
- Length: 3.44” (8.74 cm)
- Thickness: 0.30” (0.75 cm) to 0.38” (0.96 cm)

Top and side views of the radio modem are shown on the next page.

Weight

The RIM 801D weighs 2.3oz (64g), including the case.

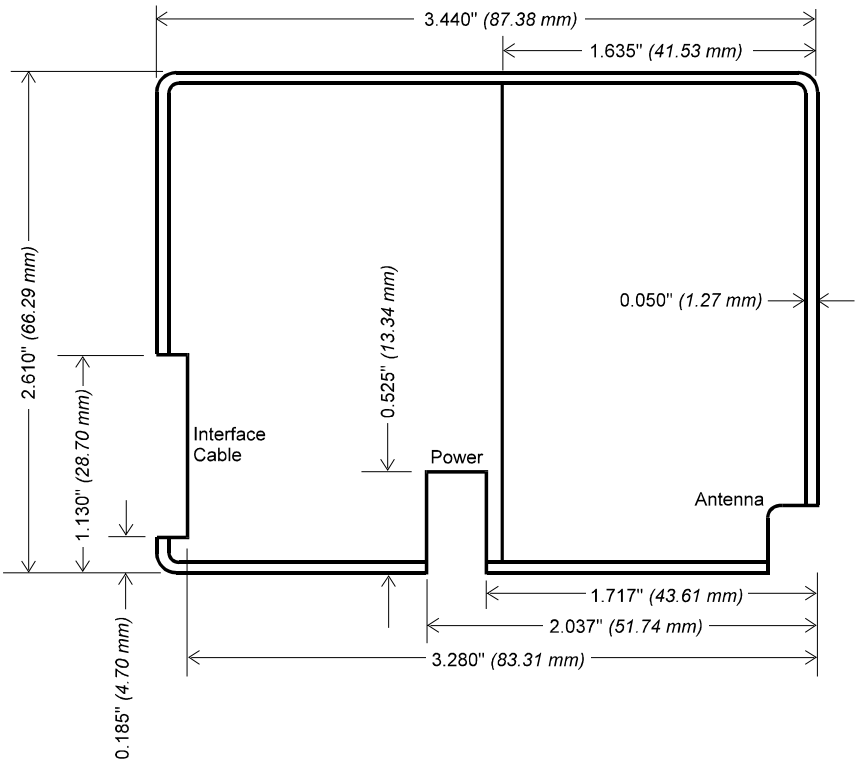


Figure 1: Top view of RIM 801D

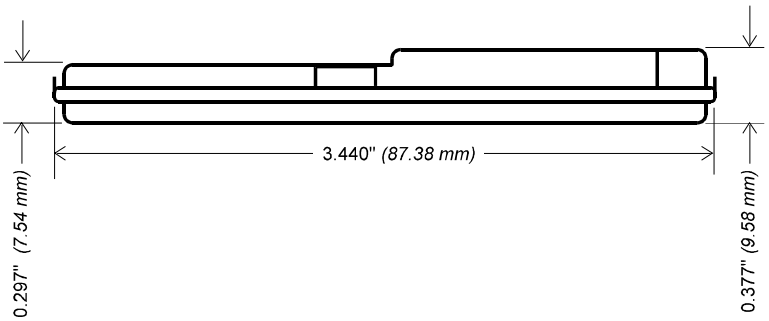


Figure 2: Side view of RIM 801D

Mounting the RIM 801D

The RIM 801D OEM radio modem may be securely fastened using a variety of methods. When deciding on a mounting option, the most important consideration is the operating environment. Such factors as extreme temperature or heavy vibration may dictate the need for a special mounting solution.

Due to the RIM 801D's small size and low weight, Research In Motion recommends the use of an industrial adhesive when attaching the radio modem to the host device. This method of mounting is preferable to bolts, because of its ease of use in manufacturing and its resistance to loosening. An effective solution is to adhere the radio modem to the inside surface of your product's casing.

The designer should select an adhesive based on its suitability to the mounting surface of the radio modem as well as the casing. The outer casing of the RIM 801D is pre-tinned steel or stainless steel, with a thickness of 0.010" (0.25 mm).

The following information is presented as a guide, but applications can vary considerably. Please make sure that the mounting method you choose is suitable for your particular application.

Permanent adhesive

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

Testing by Research In Motion has shown that a RIM 801D radio modem, bonded to a suitable surface with VHB, should never come loose even when subject to heavy vibration. Although the use of an adhesive might *seem* inadequate or insufficient, it should be considered that this particular adhesive is extremely strong — for example, VHB tapes replace rivets in fastening side panels to the frames of ambulances. VHB adheres best to metal, and can also be used on finished wood, paper, cardboard, glass, painted concrete, and most plastics, with various ratings in bond strength. VHB will *not* bond to polyethylene or polypropylene plastics, leather, or fabric.

Please be aware that because VHB is a *permanent* adhesive, the radio modem ***cannot*** be removed once it is installed. Attempting to break the adhesive bond by twisting off the radio modem will certainly damage the unit. *There is no known solvent that will remove VHB*. If using VHB as your adhesive, please make sure that you will not need to remove the radio modem after it is installed. Otherwise, the use of a reclosable fastener is recommended.

More information about VHB may be obtained by contacting 3M Industrial Tape and Specialties Division. The publication number for the VHB technical data sheet is 70-0702-0266-1(104.5)R1. Please refer to -

Appendix II for complete contact information.

Reclosable Fasteners

A reclosable fastener may be used to affix the RIM 801D to a surface. The use of such fasteners is useful if the radio modem might be removed at some point during the product's life. For example, the RIM 801D can be installed in a housing with no need for the end user to remove the radio modem, but the product manufacturer might later wish to do so.

The choice of reclosable fastener is governed by two factors. The first is the strength of the closure. The fastener should ensure that the closure will last long enough so the radio modem will not accidentally separate from the housing of the embedded system. The second consideration is the number of times the radio modem will be removed and refastened.

Two lines of Velcro-like reclosable fasteners are offered by 3M: Scotchmate and Dual Lock. Scotchmate is a plastic hook and cloth loop fastening system, the use of which is inappropriate to this application because it is expected that the radio modem would eventually come loose. Dual Lock is a sturdier, more rugged design that is appropriate to this task. The use of Dual Lock, alone or in combination with Scotchmate, offers excellent fastening while retaining the capability of removing the RIM 801D.

Different applications have different fastening needs. The combinations suitable to most applications are outlined below:

- *Attaching the RIM 801D to a rigid surface.* The use of Type 400 Dual Lock with Type 170 Dual Lock is a universal combination, suitable for most situations where the RIM 801D is affixed to a rigid surface. (The "Type" number, 400 or 170, refers to the number of interlocking mushroom-shaped stems per square inch.)

The RIM 801D can be removed and reattached as often as necessary using this method.

- *Attaching the RIM 801D to a flexible surface.* Using Type 400 Dual Lock on both surfaces offers the maximum tensile disengagement of 55 psi (380 kPa). The RIM 801D can be removed and reattached as often as necessary using this method.

- *Maximum holding power.* A high-strength closure may be obtained by mating Scotchmate Loop (on the RIM 801D) with Type 170 Dual Lock (on the attaching surface). The peel strength of this combination is very high, at 10 pounds/inch (17.5 N/cm). This solution offers the highest possible long-term holding strength, but it limits the number of times the RIM 801D could be removed to between 20 and 50. Please be aware that the radio modem may tend to "wiggle" a little bit because of the loops. This may give the *appearance* of a loose bond, although the radio is in fact held in place quite securely.

It is necessary to choose the adhesive backing on the fastener strips (rubber adhesive, acrylic adhesive, or VHB) so that it is appropriate to the attaching surface. Either backing will attach to the RIM 801D's steel casing, although VHB is recommended for its greater strength. However, VHB will not adhere to polyethylene or polypropylene plastic, for which rubber adhesive is recommended.

The disadvantage of these reclosable fasteners is that they will add slightly to the thickness of the radio modem. The engaged thickness of the combinations above will be from 0.19" to 0.23" (4.8 mm to 5.8 mm).

More information about 3M's reclosable fasteners may be obtained by contacting 3M Industrial Tape and Specialties Division and requesting publication number 70-0704-5609-3(833)JR.

Other solutions

You may determine that other mounting solutions — such as cable, twist ties or brackets — are more effective for your particular application. In all cases, it will be important to ensure that the RIM 801D OEM radio modem remains securely attached, even when subject to the most extreme vibration and temperature anticipated in the operating environment.

3

Power requirements

The RIM 801D OEM Radio Modem must be provided with a clean, high current power source. This can be provided by a plug-in power supply unit, a rechargeable battery pack, or single use batteries. RIM has conducted extensive research and has developed guidelines for integrators to follow when designing the power supply system for the RIM 801D OEM Radio Modem.

Care should be taken when supplying power to the RIM 801D. Connecting with the wrong polarity will damage the radio. We recommend protecting the radio from reverse polarity by attaching a Schottky diode in series with the Radio Modem's power cable if there is any danger of reverse connection. A 1N5822 is suitable for this purpose.

Load specifications

The RIM 801D OEM Radio Modem draws its power in bursts; the power required can change rapidly as it begins or ends a transmission. The load profile is given on the following page. These specifications should be used when choosing the battery or power supply system for your application. They can be given directly to your power supply designer or battery supplier. Please note that these specifications are subject to change without notice.

Power Design

Maximum voltage without damage	10.5 Volts
Maximum operating voltage	9.5 Volts
Minimum operating voltage	6.0 Volts
Maximum current (at 7.2V)	1.3 Amps
Recommended fuse size (external)	3.0 Amps
Total supply impedance recommended (external)	1.5 Ω (max)
Recommended operating voltage range	7.0 to 9.0 Volts

Load Profile

Express mode (typical)	60 mA
Standby mode (typical)	12 mA
Transmit current drain	
typical (1.5 W to antenna)	900 mA
peak instantaneous	1.25 A
Battery saving mode (typical) (1% Tx, 5% Rx, 94% Standby)	24 mA
Transmit duration	
minimum	21 ms (RD-LAP@19200)
maximum	1.1 seconds (MDC)
Ramp up time (from Continuous to Transmitting)	1 ms
Ramp down time (from Transmitting to Continuous)	1 ms
Off current consumption (typical)	≤ 100 µA

Automotive supplies

If you plan to power the RIM 801D from an automotive supply, extra protection must be included to protect the radio modem from the intense power fluctuations experienced when the automobile is started. A circuit comprising inductors, transorbs and voltage regulators should be used to ensure the radio modem is protected from these power fluctuations.

Commonly, in automotive applications, voltages may be as high as seventy volts on the battery, especially during starting. Commercial automotive adapters are available that will safely convert the 12 volt automotive supply to a regulated 8 volt supply suitable for operating the RIM 801D radio modem.

Supplying the RIM 801D with more than 10.5 volts will damage the modem.

Rechargeable batteries

For battery-operated applications requiring a wide operating temperature, RIM recommends using Nickel-Cadmium (NiCad) batteries to power the radio unit. Nickel-Metal-Hydride and Lithium Ion cells may also be used, but the cell temperature specifications may inhibit operation at temperatures below freezing.

The cells chosen should be able to meet the load specifications of the RIM 801D. RIM has found that a six-cell AA NiCad battery pack provides a good balance of size and performance. For space-restricted designs, AAA NiCad cells will require about one-third the volume, but provide only about one-fifth of the transmit time.

Using cells smaller than AAA is not recommended, as these cells do not generally have the capacity to sustain a high rate of transmission.

Single use batteries

When using single use cells, RIM has found that only Alkaline cells provide the high current necessary for transmission. AA, AAA, and even square 9 Volt batteries provide an excellent power source. The following graph was generated by a simulator, not an actual radio modem; it depicts the various transmit capacities of some standard "off the shelf" batteries. The transmit current used for these tests was 1.25 Amps. In normal operation, the transmitter will draw less than 1 Amp average.

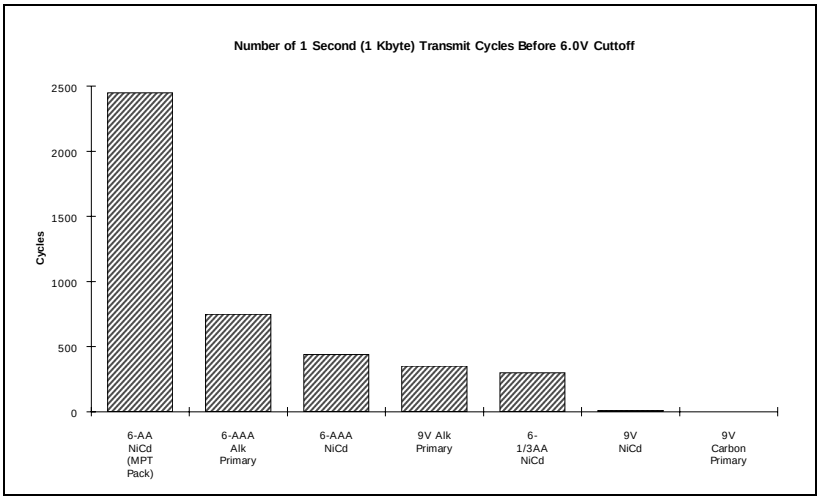


Figure 3: Battery Transmit Power Comparison

Clearly, AA batteries provide the best transmission capacity. Note that alkaline batteries are not efficient at high currents, which causes their transmit capacity to be smaller than expected, but still better than NiCad.

The use of general-purpose carbon-based batteries is not recommended, as the power supplied will drop to below the minimum required almost immediately.

Plug-in supplies

A plug-in supply converts normal AC power (usually 110 volts or 220 volts) into a steady DC source that can be used instead of batteries. The plug-in supply must be designed to ensure voltage spikes, lightning, and other power fluctuations cannot damage the radio modem.

RIM recommends a supply capable of providing 8 volts and 1.5 amps peak current. This can be accomplished by employing a 12 volt 1.5 amp peak (1.0 amp continuous) unregulated power source, and adding an 8 volt regulator (such as an LM7808).

The schematic drawing for a sample plug-in supply is provided below. This circuit provides 8 volts DC to operate the RIM 801D, as well as 5 volts for the embedded system VCC. Please note that it is not necessary to supply the RIM 801D with a 5 volt VCC — there is only one power source to the radio modem, and that is the 8 volt supply.

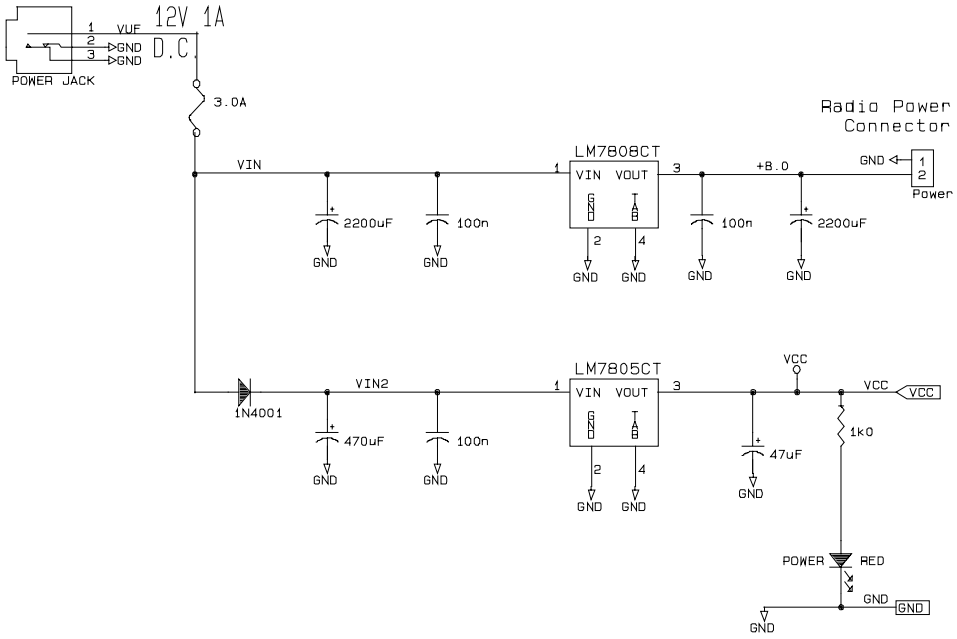


Figure 4: Sample plug-in supply

Transient voltage protection zener diodes, or other spike arrestor circuits, should also be added to keep the inputs within the limits given in the RIM 801D load specifications. These should have a value of 20 volts and be placed on the supply side of the regulator circuit.

Connecting the power source

Whatever the power source, it must be connected to the RIM 801D through the power input pins on the side of the radio modem. The mating connector is a Molex 51005-0200, 2.00 mm (0.079”) wire-to-board housing, plus two pieces per modem of Molex 50011-8100 wire-to-board 3/32” crimp terminal. (Please see page 54 for more information.) This will connect to two 24 gauge supply wires in your system.

4

Serial interface specification

The serial interface on the RIM 801D operates at HCMOS electrical levels. This interface can be connected directly to a micro-controller, or through a UART to a microprocessor data bus.

Signal specifications (Standard 5V interface)

Outputs

Output High Voltage @ 10µA	4.5 Volts Min.
Output Low Voltage @ -10µA	0.4 Volts Max.
Short Circuit Current	24 mA Max.
Recommended Output Capacitance (To Filter Interface Lines)	390 pF

Inputs

Input High Voltage	3.5 Volts Min.

Input Low Voltage	1.5 Volts Max.
Input Leakage Current High	1.0 μA
Input Leakage Current Low	-1.0 μA

The RIM 801D can also be customized for 3.3 volts.

Connecting the serial cable

The RIM 801D serial communication and power on/off signals are carried on a flat 14-conductor flexible printed circuit (FPC) cable, which can plug into a matching connector.

An appropriate 4" 14-pin cable is available from Molex Canada, part number 88-00-8025. Different lengths and orientations are also available.

The cable can plug into a matching connector such as an AMP 1.0 [0.039] FPC connector, surface mount, model 1-487951-4 (Please see -

Appendix II for contact information)

Example pictures of the FPC cable and connectors are shown below:

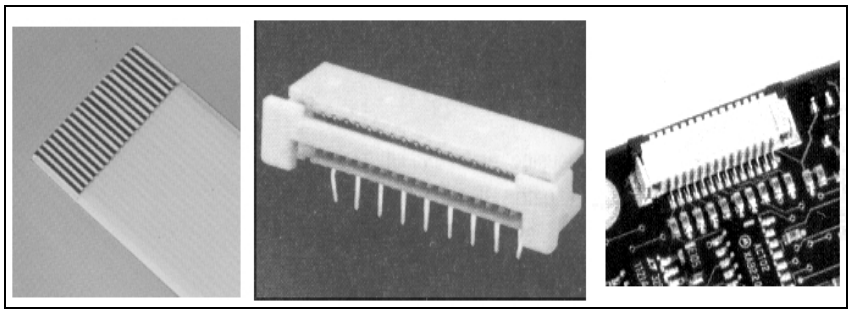


Figure 5: FPC cable and connectors

Detailed pin description

This section describes the purpose of each of the 14 lines that comprise the serial interface of the RIM 801D OEM radio modem.

Note that *any unused inputs should be tied to ground* (with the exception of DNC1 and DNC2).

Pin	Label	Source	Active	Description
1	DNC1	RAD		Do not connect to VCC or GND
2	RX	Radio		Serial Data output from Radio to Host
3	TX	Terminal		Serial Data input to the Radio from Host
4	$\overline{\text{DTR}}$	Terminal	Low	Data Terminal Ready input to Radio from Host
5	SG	N/A		Signal Ground (Internally connected to Pin 14)
6	$\overline{\text{DSR}}$	Radio	Low	Data Set Ready output from Radio to Host (Internally connected to PIN 4)
7	$\overline{\text{RTS}}$	Terminal	Low	Request to Send input to Radio from Host
8	$\overline{\text{CTS}}$	Radio	Low	Clear to Send output from Radio to Host
9	$\overline{\text{RI}}$	Radio	Low	Ring Indicator output from Radio to Host
10	DNC2	Terminal		Do not connect to VCC or GND
11	TRI	Radio	High	Transmit Indicator Output from Radio to Host
12	ONI	Radio	High	On Indicator Output from Radio to Host
13	TURNON	Terminal	High	Turn On input to Radio from Host
14	SG	N/A		Signal Ground (Internally connected to Pin 5)

Table 1: Serial Interface Pin-out and Description

DNC1 and DNC2

These are **"Do Not Connect"** pins. They are used for internal testing of the Radio hardware by RIM. *Connecting these pins to VCC or Ground can damage the radio*. Simply leave these pins disconnected when integrating the radio modem into your device.

RX

Receive is an output from the radio unit to the host terminal's Receive input. This is a TTL/CMOS compatible output that is short-circuit protected. This line can be connected directly to the input of almost any asynchronous communications IC.

This line has an impedance of 1 kΩ and will be low when the radio unit is off. The idle (no data) state of this line is high.

TX

Transmit is an asynchronous serial input to the radio unit, and can be connected directly to the output of almost any asynchronous communications IC. This line must be driven by a source with an impedance of 20 kΩ or lower for operation at high baud rates.

This line is held low through a 20 kΩ resistor when the radio is off. The idle (no data) state of this line is high.

$\overline{\text{DTR}}$

Data Terminal Ready is an input to the radio unit and is used to signal that the Host terminal is ready. When the radio is on, asserting this line low will cause DSR to also go low, and will allow communication to take place. Asserting this line high will turn communications off, and will cause DSR to go high.

DTR should be driven low when the radio is off. Driving DTR high when the radio is off can cause improper operation, may cause DSR to change state to an indeterminate value, and will consume unnecessary power.

SG

Signal Ground should be tied to the system ground of the host unit. The radio must also be grounded with the main power cable to assure proper operation .

$\overline{\text{DSR}}$

Data Set Ready is an output from the radio unit. This signal is electrically connected to the DTR input and will therefore have the same properties as the Host's DTR output.

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

RTS

Request To Send is an input to the Radio unit from the host. This line should be asserted low by the host to indicate that data is waiting to be sent.

$\overline{\text{CTS}}$

Clear To Send is an output from the Radio unit that indicates it is ready to receive data from the Host. When this line is high any data sent from the Host to the Radio may be lost.

This line will be low from inside the radio modem with an impedance of at least 20 kΩ.

$\overline{\text{RI}}$

Ring Indicator is an output from the Radio that can be used to wake up a sleeping Host system. If the radio is flow controlled off (DTR or RTS asserted high) and the Radio receives a packet, it will assert RI low to alert the Host system that there is a data packet waiting.

This line is low when the radio is powered off, and has a source impedance of 21 kΩ (when high) or 1 kΩ (when low).

TRI

Transmit Indicator is an output from the radio that is asserted high whenever the Radio is transmitting a packet. This line can be used as feedback to the host to ensure the radio is transmitting packets, or it can

simply be left disconnected. This line has a built in current limit that allows it to drive an LED directly as visual feedback for a user.

This line will supply 3 mA to a standard LED, and is short-circuit protected. This line is low when the Radio is off.

ONI

ON Indication is an output from the radio that indicates when the radio is on and operational. This line should be used by a host system to qualify the handshaking outputs on the serial interface. If CTS is low, and ONI is high, then the unit is ready to receive data, but if CTS is low and ONI is low, then the radio is not ready to receive data because it is off.

When ONI is low, all inputs to the radio should be held low or disconnected to assure the unit power consumption is minimized.

ONI has an output impedance of 1 kΩ.

TURNON

This input turns on the radio unit – a TTL and CMOS compatible signal. This pin's electrical characteristics are different from the others, as shown in the table below.

Input High Voltage	2.5 Volts Min.
Input Low Voltage	0.8 Volts Max.
Input Leakage Current High	500 μA Max.
Input Leakage Current Low	-50 μA Max.

Due to the higher current requirements of this pin, a direct drive CMOS or TTL output must be used. An open-collector output could also be used, provided it is pulled up by a 10 kΩ resistor or smaller.

Turning the radio ON

To turn on the RIM 801D, the software should first check the ONI pin. If ONI is high, but TURNON is being held low, then the radio is currently performing shutdown operations and should not be disturbed. Wait for ONI to go low before continuing.

If ONI is low, this indicates the radio is in the off state. Set the TURNON line high to activate the unit. The ONI pin will respond by going high from 100 - 500 ms later. Once the ONI pin is high, other handshaking and communication signals can begin.

If the radio does not respond to the TURNON signal within 1 second, the TURNON line should be de-asserted. Another TURNON cycle should then be attempted. If the radio still fails to respond, the radio may require service, or the battery may be too low for proper operation.

Turning the radio OFF

To turn the RIM 801D off, the software should de-assert the TURNON line by setting it low. The radio will then begin shutdown operations. All inputs to the radio should also be set low. The ONI pin will remain active until all shutdown operations are complete. Attempting to communicate with the Radio during shutdown may extend the time taken to perform shutdown operations.

Shutdown will normally require several seconds to complete. Upon completion the ONI signal will be de-asserted (low). All inputs to the radio must now be set low, if they are not already low. This ensures that power consumption will be reduced to the lowest possible levels. Note that if any line is left in the high state, as much as 5 mA may flow into the radio modem.

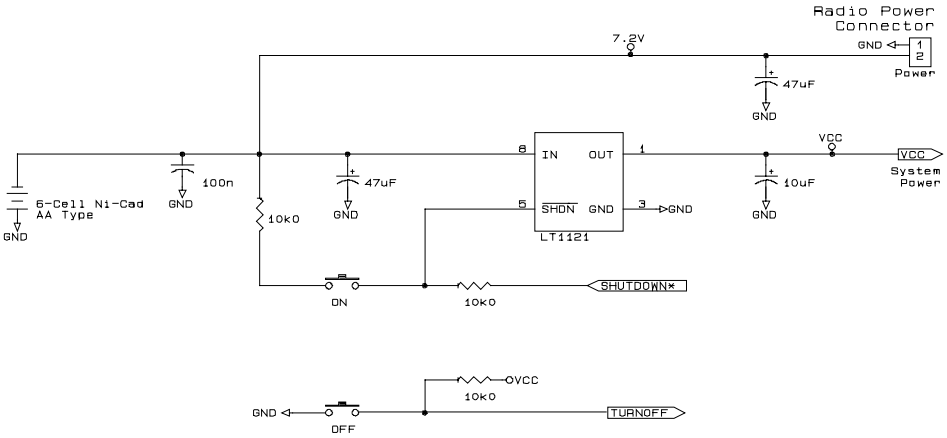
Flow control inputs that are not used may be tied to ground. This ensures that they will be asserted during radio operation.

SDUs (Service Data Units) which have been received over the DataTAC network to radio link, but which have not been transferred across the radio

modem to terminal link, *will not be saved*. The SDU will be lost when the unit enters shutdown or is turned off.

A controlled shutdown is necessary to allow the RIM 801D to tell the DataTAC network that it is off air. The following schematic offers a low-power shutdown circuit, together with an example of using a 6-AA NiCad rechargeable battery pack to power the RIM 801D.

Please note that in the following circuit, the signals marked *Shutdown* and *Turnoff* are not connected to the RIM 801D radio modem, but to the processor of the embedded system. If no processor is present, the *Turnoff* line can be tied to the RIM 801D's *Turnon*, and the *Shutdown* signal can be tied to the RIM 801D's *ONI* line.



The ON button forces the system to turn on. The processor then sets the SHUTDOWN line high. When the button is released the system stays on.

The OFF button sends a request to the processor to shutdown. The processor will then set the SHUTDOWN line low after the radio has been shutdown.

If no processor is present, the TURNOFF signal can be tied to TURNON and SHUTDOWN can be tied to ONI of the RIM 801D radio.

Figure 6: Controlled Shutdown Using a Low-Power Battery Supply

5

Antenna integration

The choice of antenna is important to maximizing the coverage area of the RIM 801D radio modem. It is important to choose an antenna that will best compliment the needs of a specific project. There are many different antenna options that will meet both your gain and directivity requirements and remain within budget constraints. Three well-known antenna manufacturers that have experience with DataTAC frequencies are Larsen, Austin Antenna and Antenna Technology Inc. (Please see -

Appendix II for contact information). Research In Motion Limited can also provide antenna design services.

Antenna requirements

The RIM 801D OEM Radio Modem transmits on frequencies between 806 MHz to 825 MHz. Receive frequencies are between 851 MHz and 870 MHz.

Antenna gain

Antenna gain is dependent on the radiation pattern, antenna match, and antenna efficiency. Antenna gain is a rating of the maximum increase in radiated field energy density relative to an ideal *isotropic radiator*, expressed in decibels (dB) of power gain.

An isotropic radiator is an unrealisable theoretical reference for measuring antenna gains and patterns. It is based on a 100% efficient point source

radiator with a spherical radiation pattern. That is, the field energy density is identical in any direction from the radiator at each fixed distance from the radiator.

Antennas produce gain by concentrating radiated energy in certain areas, and radiating less energy in other directions.

Antenna match

Antenna match is related to the Voltage Standing Wave Ratio (VSWR), a ratio of incident and reflected power due to impedance mismatch and antenna efficiency. Impedance mismatches can be due to cable connections, cable lengths, and imperfections in the cables and connectors. The mismatch causes some of the radio frequency energy to be reflected back from the location of the mismatch, which interferes with the signal and reduces its amplitude, resulting in a power loss.

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

Equation 1: VSWR

Antenna mismatch can be expressed as a **Return Loss** (**RL**): a 10 x $\log_{10}$ of the ratio of reflected power to the incident power.

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

Equation 2: Return Loss

The antenna match for ***"best performance"*** is a VSWR ≤ 1.5 or a RL < -14 dB.

The antenna match which is the ***minimum acceptable*** for the RIM 801D is a VSWR ≤ 2.0 or a RL < -10 dB.

Antenna efficiency

The optimal antenna radiation efficiency is produced by a monopole. The *best* antenna length is the length of the wavelength, λ. Where f is the radio frequency being used, $\lambda = c/f \approx 3x10^8 / f$ (metres).

Antenna lengths of λ/2, λ/4 or 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.

RIM recommends the use of an experienced antenna provider in order to realize the highest gain possible. A well-designed antenna solution will maximize efficiency, coverage area, and battery life.

Positioning the antenna

Proper positioning of the antenna will maximize the gain provided by the antenna. In determining the "proper position," the designer must carefully consider the environment in which the device will be used. There is no single "correct answer," as embedded systems can vary significantly. Incorporating the antenna is an integral part of a successful design.

The DataTAC network is based on vertically polarized radio-frequency transmission. Therefore, the antenna should ideally be oriented so that it provides vertical polarisation. This is achieved by positioning the antenna vertically upward when the RIM 801D is in use. In small, hand-held devices, it may be convenient to design the unit in such a way that the antenna folds out of the way when not in use.

The antenna should be located as far from the active electronics of the computing device as possible. Metal construction in the case of the computing device and its internal components may attenuate the signal in certain directions. This is not desirable, as it would reduce the sensitivity and transmit performance of the radio modem.

If the computing device is designed to sit on a surface, then the antenna should be as far from the bottom of the device as possible. This will reduce RF reflections whenever the device is placed on a metal surface.

When the computing device is hand-held or is worn next to the body of the user, the antenna should be positioned to radiate away from the body. Otherwise, the effective coverage area of the radio will be reduced.

Antenna cabling

The RIM 801D radio modem must be connected to an antenna with a suitable low loss matching cable, with an impedance of 50 Ω.

Connecting directly to the RIM 801D

On one corner of the RIM 801D is an MMCX connector, to which an antenna cable is attached. On one end of this cable is an MMCX connector, and on the other end is an SMA connector. This connector may be bolted onto the case of a wireless device. An antenna is then connected to the SMA jack. This general arrangement is shown in the diagram below.

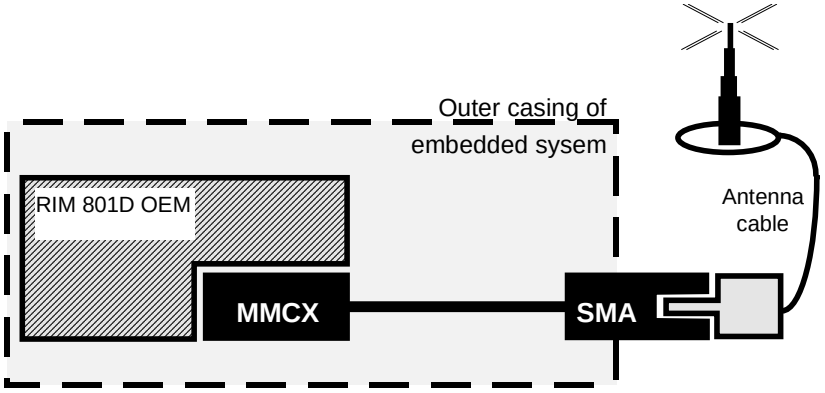


Figure 7: Connecting an antenna

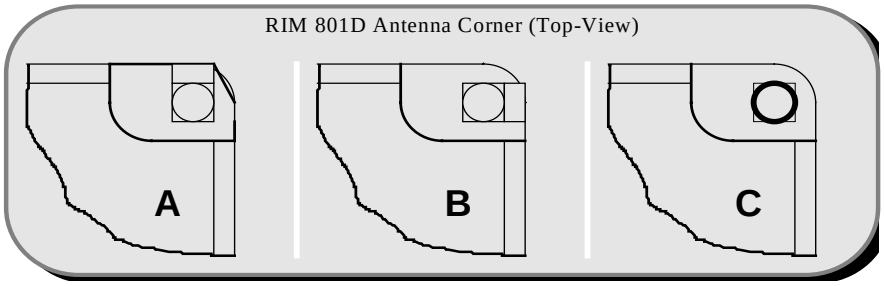


Figure 8: Different MMCX Connector Orientations

There are many orientation options available when connecting your antenna cabling to the RIM 801D. Figure 8 shows the top-view (as shown in Figure 1) of the antenna corner. The RIM 801D is available with one of three different connectors: **A)** the right-angle, end-mount MMCX connector; **B)** the right-angle, side-mount MMCX connector and **C)** the straight, vertical MMCX connector.

Different orientations give you more options when positioning the modem in the terminal. The Straight and/or right-angled MMCX connectors can also be ordered with, or separately from antenna cabling. The combinations of MMCX connectors of both the antenna cabling and the RIM 801D allow many different positions. For example, an antenna cable with a straight MMCX connector can be fixed to point directly out from the RIM 801D in the direction of the different modem connectors (see Figure 8), or an antenna cable with a right-angle MMCX connector can be fixed to the RIM 801D to allow the cable to rotate 360° along the face, long, or short side of the RIM 801D.

Huber & Suner can provide an 8" cable assembly. A suitable cable is the EZ Flex 405. The part number for this cable with a straight MMCX connector is Huber & Suner Canada Part #: 133REEZ4-12-S2/1699 Length 203mm. The cable is also available with a right-angle MMCX connector Part #: 133REEZ4-12-S2/1699. Alternately, the connectors and cable can be purchased individually. The SMA connector's part number is 25SMA-50-2-25/111. The straight and right-angle MMCX connector's part numbers are Part #: 11MMCX-50-2-1C/111 and Part #: 16MMCX-50-2-1C/111, respectively. Less expensive, but lower performance cable assemblies can also be purchased. Please contact RIM for details. The cable should be built with strain reliefs to prevent damage.

Other SMA jack connectors are the M/ACOM OSM (SMA) for flexible cable, **(A)** Straight Cable Jack part number 2032-5007-02 (RG 142), **(B)** Bulkhead Feedthrough Cable Jack part number 2034-5004-02 (RG 142), or

(C) Flange Mount Cable Jack part number 2036-5003-02 (RG 142). Pictures of these three are shown below. Please refer to -

Appendix II for contact information for both M/ACOM and Huber&Suner.

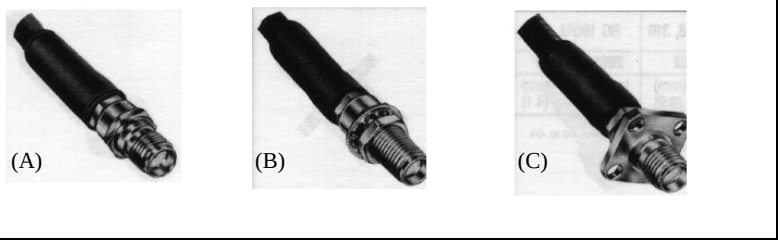


Figure 9: Example SMA Jack Connectors

RIM offers a comprehensive Developer's Kit for the RIM 801D to assist system designers. Included in the kit is a 50 Ω antenna cable. This cable has been matched to the radio modem and may be directly connected to a suitable antenna, such as the 6 dB Magmount antenna that is optionally included with the kit.

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

If the device will be used in vehicles, then it should be provided with a connector which allows the user to attach the antenna directly to the case, or to attach a cable which leads to an antenna mounted on the exterior of the vehicle.

Shielding

The RIM 801D is designed to provide high immunity to RF noise; consequently, it will not be necessary to provide special shielding. In fact, it is more important that the *power supply* to the RIM 801D be free of high-

frequency electrical noise, than to provide additional RF shielding between other computing devices and the RIM 801D case.

The RIM 801D case provides shielding to prevent it from being affected by RF interference from the computing device to which it is attached. The case also prevents the RIM 801D from emitting RF energy into the computing device and disrupting the computing device's operation.

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

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

6

Protocol support

The RIM 801D OEM radio modem offers two link-level protocols: **NCL** (Native Control Language) and **RAP** (Radio Access Protocol). Both protocols serve the same function: they control the exchange of DataTAC data packets and radio control commands between the radio modem and the host device.

RAP offers several advantages over NCL when used with the RIM 801D, or other applications where the radio modem is physically located close to the host device. RAP is a scaleable protocol that is easy to implement, it uses only 1 to 3 K of program storage. RAP helps application developers simplify software development on small-memory devices like PDAs, vending machines, POS terminals, alarm panels, and other embedded systems.

This chapter describes SDUs, the packets of data which are exchanged over the DataTAC wireless network. Following this is an examination of the NCL and RAP protocols. For more detailed technical documentation, please refer to RIM's *Programmer's Guide to RAP and SDUs*.

Service Data Units (SDUs)

The DataTAC network transfers user data in packets called SDUs, short for **Service Data Units**.

DataTAC Logical Link Identifier (LLI)

The *DataTAC Logical Link Identifier* (LLI) is a 32-bit number which uniquely identifies each radio on a DataTAC network. This number is assigned by the DataTAC network operator, and is usually printed on the radio modem.

An LLI is conceptually analogous to a telephone number. In addition to its own LLI, a radio modem can belong to up to 16 *Group LLIs*, which allows it to receive a copy of all data sent to the Group.

SDU Types

DataTAC defines many different SDU types. If you have looked into the DataTAC Open Protocol Specification, then you already know that there are dozens of different SDU types. However, most of these SDU types are for private use between the radio modem and the DataTAC network.

There is only one SDU type that is of interest to a programmer. User data SDUs contain user data which is destined for the DataTAC network.

SDU headers

All user data SDUs start with a variable length user header.

VHO	Length	User header data

The first two bytes define the user header length and are referred to as the UHO length. This is a 16-bit binary value in big-cadian format (MSB, LSB).

The user header consists of network routing information and is dependent on the particular network routing information being used.

The DataTAC Open Protocol Specification on DataTAC Messaging (68P04025C10-O) contains information on user header formats for DataTAC networks.

NCL Protocol

The NCL, Native Control Language, protocol is a link layer protocol, designed to govern communication between a radio modem and a host device over a serial cable link. NCL carries SDUs to and from the radio, as well as any radio control instructions. NCL is available in all DataTAC radios, including the RIM 801D.

SDUs are carried inside NCL frames. In addition to the data, the NCL frame contains start and end characters. When the radio modem and host system exchange an NCL frame, considerable handshaking is taking place in order to ensure reliable transfer over the serial link.

The DataTAC Open Protocol Specifications on Native Control Language (NCL) (68P04025C10-O) includes a complete protocol specification and contains detailed information about NCL frames and frame types.

Radio Access Protocol (RAP)

RAP (Radio Access Protocol) is a simple, connectionless link layer protocol, designed to communicate with and control the RIM 801D radio modem, and to send and receive information over the wireless network

A RAP program transfers data packets (e.g. SDUs) and radio control commands between an embedded system and the RIM 801D over an asynchronous serial port, using RAP's framed link protocol. The RAP program is *not* concerned with the transfer of data between the RIM 801D and a DataTAC network base station, as the RIM 801D completely handles transmission and reception.

When to choose RAP over NCL

RAP helps application developers simplify software development on small-memory devices like PDAs, vending machines, POS terminals, alarm panels, and other embedded systems. With NCL, the amount of software required to implement the NCL interface can be greater than the available memory. With RAP, a complete DataTAC radio interface needs only 1 to 3 Kbytes, compared to the typical NCL implementation that requires generally more Kbytes. This increases the memory available for applications.

The RIM 801D OEM radio modem includes on-board support for both NCL and RAP. Even when in RAP mode, the RIM 801D can detect certain NCL frames arriving on the serial port. This will cause the radio to automatically switch to NCL mode. RIM has included both protocols on the RIM 801D to maintain backward compatibility with existing applications.

RAP implementation assumptions

As a communication protocol, RAP was created under the following assumptions:

- Simple serial packet interface is easiest to test and verify.
- Microcontrollers with limited memory are able to send a packet, receive a packet, control the radio, and obtain status from the radio.
- Microcontrollers must add code to support a RAP radio.
- RAP is simple enough that an API is not required.
- Data integrity is assured with checksums, but the checksums are optional if there are no CPU cycles to spare for the calculation.
- The serial link used by RAP is not prone to bit errors. However, embedded applications might miss individual characters due to receiver over-runs while they are busy handling other functions. RAP provides recovery capability for missed characters.
- Data is formatted by the microcontroller and sent through RAP; RAP does not have any SDU formatting functions.

- A radio configured to operate in RAP mode can detect certain NCL frames arriving on the serial port, and will automatically switch to operating as an NCL radio.

The RIM *Programmer's Guide to RAP and SDU's* includes a complete protocol specification and contains detailed information about RAP frames and frame types. This information is summarized below.

RAP frame structure

An *n*-byte RAP frame has the following structure:

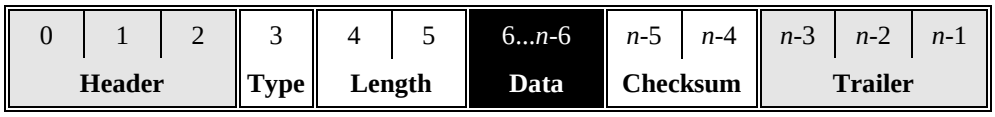


Figure 10: RAP Frame Structure

All parts of the RAP frame are necessary elements of the RAP implementation.

The **header** consists of a unique sequence of values (0x9D, 0xAE, 0xBF). This signals the beginning of a RAP frame to the RIM 801D radio modem.

The frame **type** indicates which one of the 18 different RAP frame types is being used. The frame type determines the meaning of the data that is enclosed in the RAP frame. These types are described in the next section.

Length indicates the number of bytes that are enclosed as data. This number may be between 0 and 560.

Data is an optional field that encloses the data that is to be transmitted. When transfering data, up to 560 bytes may be sent in each RAP frame.

RAP provides error-checking in the form of a **checksum**, a simple summation of all the *header, type, length*, and *data* bytes. Error-checking is optional in RAP, but a RAP frame must *always* include a checksum field. When error-checking is not used, the checksum bytes must be set to zero.

The frame ends with a **trailer** which, like the header, consists of a specific sequence of values (0xFB, 0xEA, 0xD9). If the checksum received is correct, then the trailer sequence can be ignored. If the radio receives a zero

checksum, the three trailer bytes *must* be received before the frame is accepted.

Please make sure you understand that the RAP header, type, length, checksum, and trailer bytes are never transmitted to the wireless network. These bytes are used only in communication between the radio modem and the host device. Only the bytes contained in the DATA field are transmitted to the network. *When using DataTAC, the entire SDU is enclosed in the RAP frame's DATA field*, as shown in the following diagram:

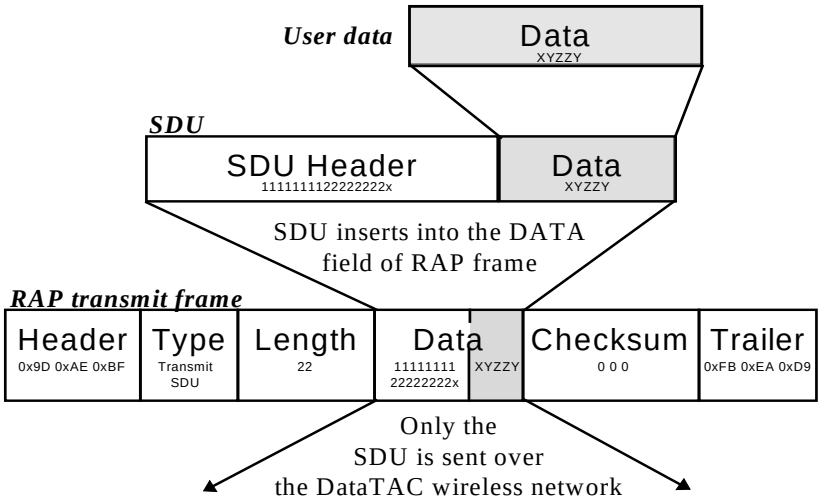


Figure 11: Sending data from the host to the wireless network

RAP frame types

There are eighteen RAP frame types. These frame types identify the type of data that is being sent. The different frame types are summarized in the table below, and discussed in greater detail in the *Programmer's Guide to RAP and SDUs*.

Please note that although the information below is specific to the DataTAC network in its use of the term *SDU*, the RAP protocol is network-independent. The term *SDU* can be freely replaced with *data packet*, the structure of which would depend on the network in use.

RAP frame types	***Description***
Transmit SDU	This indicates to the radio that the data is intended for transmission to the DataTAC network.
Receive SDU	The radio will send the host system the SDU that was received over the wireless network.
Turn off radio	This RAP frame type signals the radio to turn off.
Power-save mode	The radio will enter power-save operating mode as soon as it is able.
Express mode	The radio will enter express operating mode as soon as it can.
Turn transmitter off	The radio will abandon any transmit attempt and will turn off the transmitter.
Turn transmitter on	The radio will turn on the transmitter.
Request radio status	The radio will reply with the current radio status.
Radio status	The radio sends updated radio status to the host system whenever the radio state is changed.
Clear transmit status	This sets the current transmit status to "No transmit in progress."
Clear received SDU	The radio will delete the received SDU, and sends the next received SDU (if any).

- continued -

RAP frame types	*Description*
Request network name	This frame causes the radio to send a Current Network Name reply.
Current network name	This is the radio's reply to *Request network name.*
Set battery charge rate	This command has no effect on the RIM 801D except to set or clear the *battery charging* flag in the *Radio status* frame.
Turn radio receiver on	This frame causes the radio to turn on the receiver, and send a Radio status reply with the Receiver Ready status bit set.
Turn radio receiver off	This frame causes the radio to turn off the receiver and transmitter. Any transmit attempt will be abandoned. The radio sends a Radio status reply with the Receiver Ready and Transmitter On status bits cleared.
Request system identifier	This frame causes the radio to send a Current System Identifier reply.
Request static channel table	The radio sends a Reply Channel Table frame in response, which lists all of the channel designators stored in the radio modem's static channel table.
Request dynamic channel table	The radio sends a Reply Channel Table frame in response, which lists all of the channel designators stored in the radio modem's dynamic channel table.
Current System Identifier	This is the radio's reply to "Request System Identifier"
Reply Channel Table	This is the reply to "Request Static Table" and "Request Dynamic Table" frames.

- end -

Summary

LLI is an access number used to identify a radio modem. Each radio modem on a wireless network is assigned a unique LLI.

SDU is a packet of data that is exchanged between the RIM 801D OEM radio modem. and the DataTAC wireless network.

NCL is a communication protocol that provides for the reliable transfer of information across the serial link connecting the RIM 801D to the host device. This data can have different meanings, depending on the ***frame type*** in use. For example, the data can be intended for wireless transmission, or it could request the current radio status. The ***NCL frame***, which contains data and control sequences, is used only to communicate across the serial link, and is not transmitted to the wireless network.

RAP performs the same function as NCL, but with less extensive error-checking. Both NCL and RAP are built into the RIM801D.

7

Interfacing and controlling the RIM 801D

The RIM 801D OEM radio modem is designed to be used easily in an embedded system. This chapter presents schematics for an RS232 interface, a micro-controller, and a serial port interface. The following schematics can be used as starting points for more complex designs.

Interfacing to an RS232 device

The RIM 801D serial interface operates at HCMOS electrical levels, making it compatible with many existing system designs. In most cases, the RIM 801D can be connected directly to a micro-controller without any additional interface logic. If the radio modem is to be connected directly to a PC or other RS232 device, an interface must be provided. An RS232 interface design example is provided in Figure 12.

Controlling the RIM 801D

There are different approaches to integrating the radio modem, and these depend on the design of the embedded system. We have provided an example of a RIM 801D OEM integration using an 8051 micro-controller in Figure 13.

The 8051 is configured with:

- 32 K of ROM
- 256 bytes of RAM
- 4 lines to the RIM 801D
- 28 general-purpose control lines that can be used for your control functions.

Port 0 is “Open Drain” and all other ports are internally pulled up. Because of the small volume of data, handshaking and flow control is not required.

Serial port interface

A standard 8250 UART interface is provided for your reference. This interface may be used between the RIM 801D and a microprocessor data bus. The schematic for this interface is found in Figure 14.

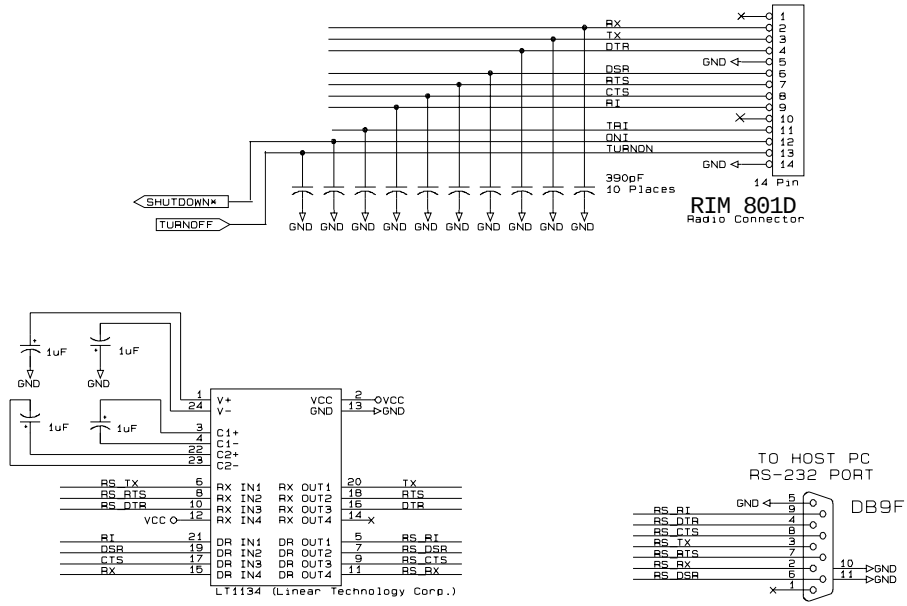


Figure 12: Simple PC RS232 Interface

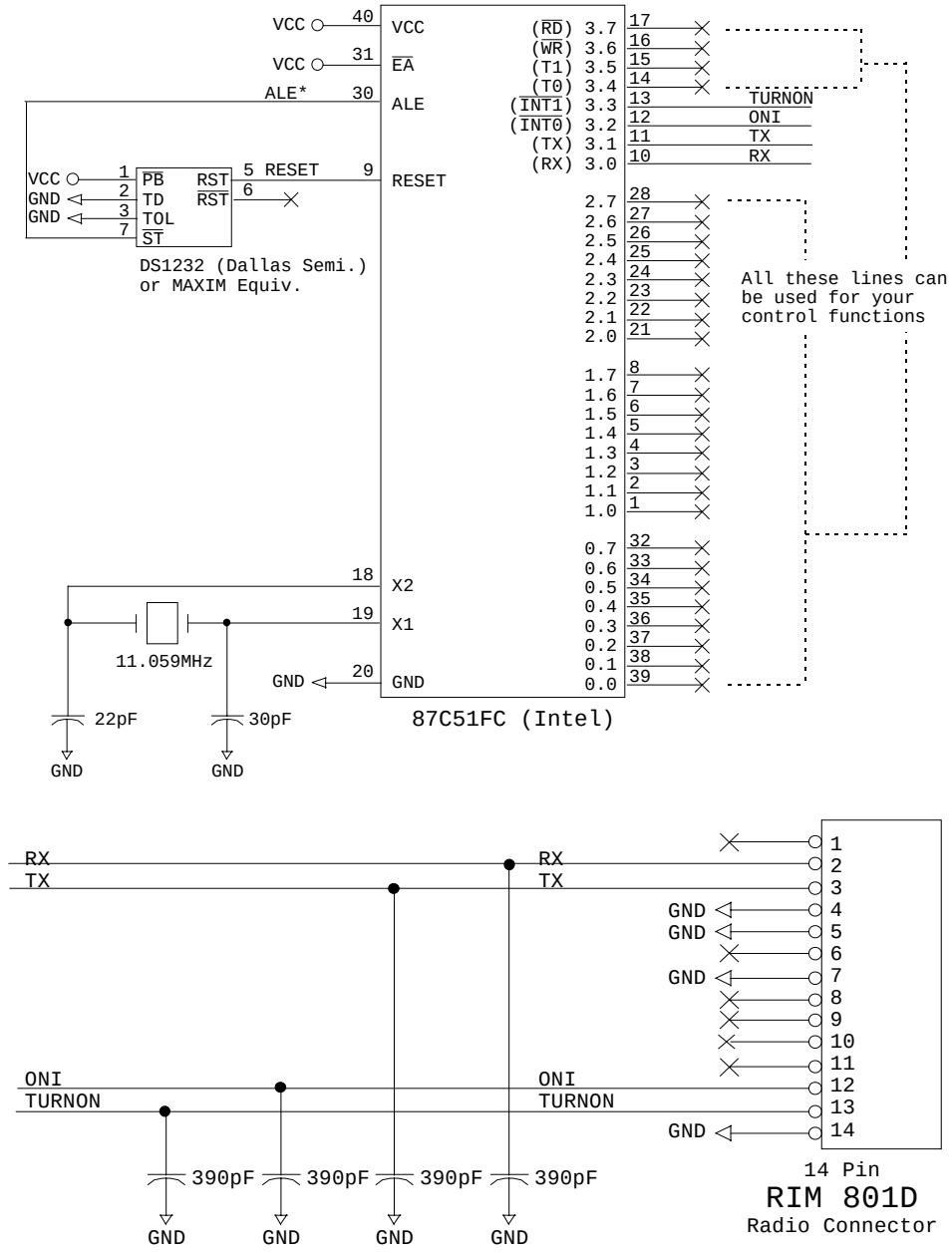


Figure 13: Simple 8051 Interface

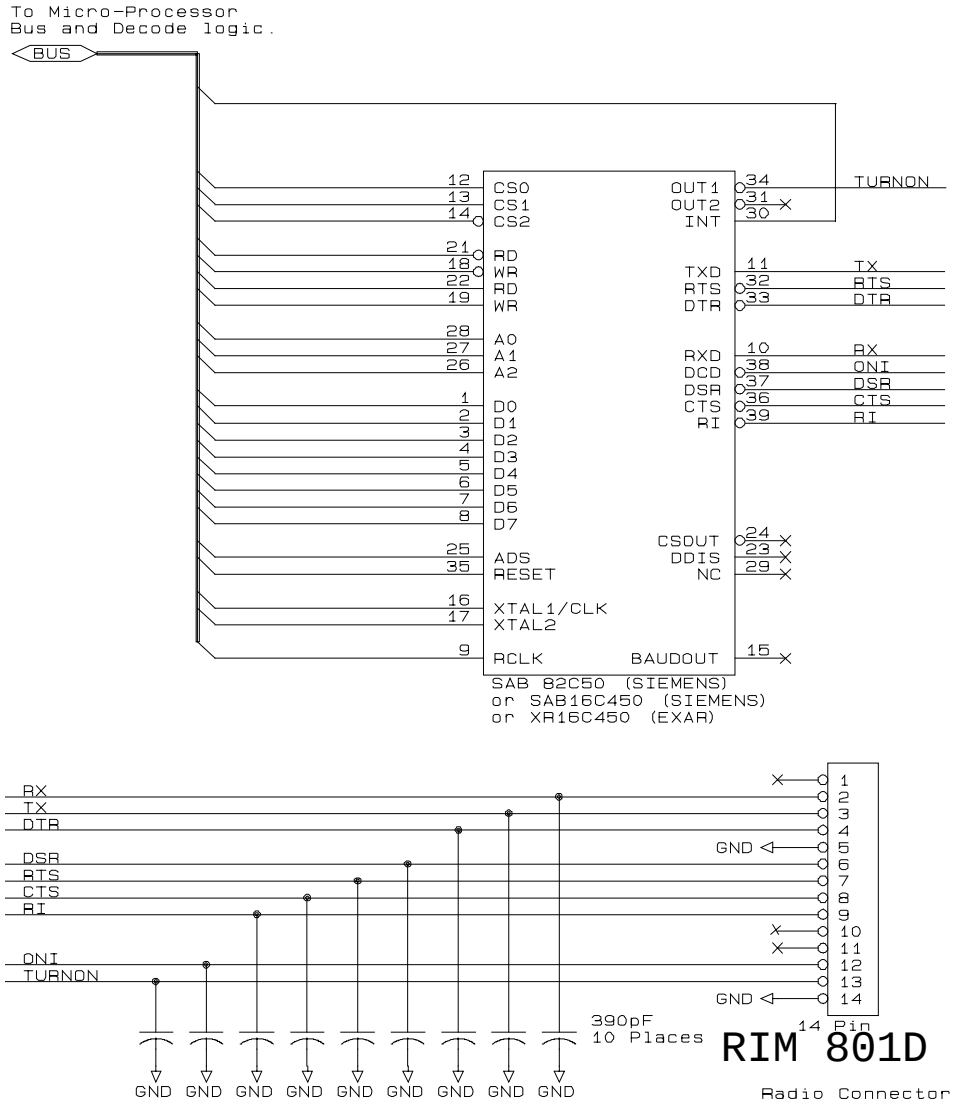


Figure 14: 8250 Serial Port Interface

Specifications

The following is a summary of the RIM 801D OEM radio modem specifications.

Power supply & typical current usage

- Single power supply; operating range: 6.0 to 9.5 VDC (7.2 V nominal)
- Single TTL-level logic line to turn on/off
- Typical off current consumption: 100µA
- Battery save stand-by mode: 12 mA
- Receive / express stand-by mode: 60 mA
- Transmit mode: 900 mA
- Average current usage: 24mA (based upon 94% standby, 5% receive, 1% transmit)

RF properties

- Transmit frequency: 806-825 MHz
- 1.5 W nominal max. transmit power at antenna port
- Receive frequency: 851-870 MHz
- Receive sensitivity: -113dBm (RD-LAP), -118dBm (MDC)
- 4800bps MDC FSK, 19.2 kpbs RD-LAP 4FSK RRC
- FCC Parts 15 & 90
- Industry Canada RSS 119

Serial communications

- TTL level asynchronous serial port
- 7 bit with parity (NCL) or 8 with no parity (RAP)
- Link speed: 1200-9600 bps
- Link level protocols:
  - Radio Access Protocol (RAP)
  - Native Control Language (NCL)

Other features

- A simple-to-use firmware utility displays radio-modem serial number, LLI, RSSI level, battery strength and various network parameters. It can also select different DataTAC networks or "ping" the network to test the radio-modem.
- Software can activate radio

- Hardware flow control
- Radio parameters stored at power down
- Terminal devices may power-down while radio-modem remains operational

Mechanical & environmental properties

- Weight: 2.3 oz. (64g), including case
- Footprint: 3.5” x 2.6” (87.5 x 66mm)
- Thickness: 0.3” to 0.38” (7.5 to 9.6mm)
- Power connector: 2mm pitch Wire-to-Board Header (Molex 53015-0210), mates to Molex 51004-0200
- TTL level serial connector: 14 pin FPC (Flexible Printed Circuit) connector (*RX, TX, DTR, DSR, RTS, CTS, RI, TRI, ONI TURNON, ground, special*)
- Antenna cable connector: MMCX
- Tested to IEC 68-2-6 Part 2 for vibration
- Operating temperature tested to: -30°C — +75°C (at 5-95% relative humidity, non-condensing)
- Storage temperature: -40°C to +85°C

Glossary of terms

Term:	*Meaning:*
c	The speed of light.
dB	decibel. A measure of power, based on a logarithmic scale.
Embedded System	A computer without the normal display, keyboard, and disk drives of a PC.
FPC	**F**lexible **P**rinted **C**ircuit. The serial communication cable on the RIM 801D is made using this type of flat multi-conductor wiring.
Gain	In this document, gain refers to increase/decrease in radiated power.
LLI	**L**ogical **L**ink **I**dentifier. Each DataTAC radio modem has one unique LLI. An LLI is a 32-bit number. The network operator will assign an LLI to each radio modem when they authorize its use on their DataTAC network.
NCL	**N**ative **C**ontrol **L**anguage. The link layer protocol exchanged via an asynchronous full-duplex serial channel between a data terminal or computing device and the RIM 801D OEM Radio Modem.
MMCX	The connector on the RIM 801D to which an antenna cable is connected.
DataTAC	A radio network and its communication protocols, developed by Motorola.
SDU	**S**ervice **D**ata **U**nit. A parcel of data transferred between the DataTAC network and the radio modem.
Network Operator	The corporation or agency which installs, maintains and authorizes use of a DataTAC network in a given area, usually within one country.
Noise	Refers to undesired, random interference combining with the signal. If the device is not immune to noise, the interference must be overcome with a stronger signal strength. Noise can be produced by electronic components.

- continued -

Term:	*Meaning:*
OEM	**O**riginal **E**quipment **M**anufacturer. Usually implies that the "OEM product" is re-labelled with another manufacturer's name. The RIM 801D is designed to be embedded in OEM terminals, PCs and data gathering equipment, and as such the equipment it is embedded in will not normally carry RIM's name.
OSI	The **O**pen **S**ystems **I**nterconnection model allows different systems, following the applicable standards, to communicate openly with each another.
Polarity	Direction of current flow. Connecting some cables with the wrong polarity (i.e. backward) may damage the device.
Radio Modem	A device which provides **mo**dulation and **dem**odulation for a radio frequency communications system.
Radiation	In this document, "radiation" refers to the emission of electromagnetic energy in the radio frequency (RF) band. Do not confuse this with radioactive particle emissions caused by nuclear reactions.
RAP	**R**adio **A**ccess **P**rotocol. An alternative to the NCL protocol, found on the RIM 801D. Provides simpler implementation and faster, reliable operation.
Return Loss	A measure of antenna matching.
RF	**R**adio **F**requency.
RS232	The standard asynchronous serial communications interface used by most existing personal computers and mini-computers. Usually refers to both the communications protocol and the electrical interface.
SMA	An RF connector type.
TTL	**T**ransistor-**T**ransistor **L**ogic. Used in digital circuits. Low (0) is represented by ~0 V and High (1) is ~5 V.
Type Approvals	These approvals are required by most governments before radio transmitters and equipment containing radio transmitters can be used. In the USA, a device must be tested and certified by an independent lab which is recognized by the FCC.
UART	**U**niversal **A**synchronous **R**eceiver/**T**ransmitter. Used as an interface between a microprocessor and a serial port.
VSWR	**V**oltage **S**tanding **W**ave **R**atio. A measure of antenna matching. See **Chapter 5, Antenna Integration**.

- end -

Appendices

Appendix I - Parts

Company Name	*Part Description & Part Number*
3M - Industrial Tape & Specialties Division [USA]	VHB technical data sheet **Part #: 70-0702-0266-1(104.5)R1** Reclosable Fasteners **Part #: 70-0704-5609-3(833)JR**
Antenna Technology, Inc. [Taiwan]	DataTAC Antennas
Austin Antenna [USA]	DataTAC Antennas
Huber & Suner [USA & Canada]	Straight MMCX connectors **Part #: 11MMCX-50-2-1C/111** Right-angle MMCX connectors **Part #: 16MMCX-50-2-1C/111** EZ Flex 405 antenna cabling (Length 183mm) with straight MMCX and SMA connector **Part #: 133REEZ4-12-S2/1216** EZ Flex 405 antenna cabling (Length 183) with right-angle MMCX and SMA connector **Part #: 133REEZ4-12-S2/1699** SMA connector **Part #: 25SMA-50-2-25/111**

- continued -

Company Name	*Part Description & Part Number*
Huber & Suner [Canada]	EZ Flex 405 antenna cabling with right-angle MMCX and SMA connector **Part #: 133REEZ4-12-S2/1699** SMA connector **Part #: 25SMA-50-2-25/111**
Larsen [USA]	DataTAC Antennas
M/ACOM [USA]	SMA jack connectors for flexible cable (Straight Cable Jack) **Part #: 2032-5007-02 (RG 142)** SMA jack connectors for flexible cable (Bulkhead Feedthrough Cable Jack) **Part #: 2034-5004-02 (RG 142)** SMA jack connectors for flexible cable (Flange Mount Cable Jack) **Part #: 2036-5003-02 (RG 142)**
Molex Canada [Canada]	4” 14-pin-FPC cable **Part #: 88-00-8025** Wire-to-board housing, 2.00 mm (0.079”) **Part #: 51005-0200** Wire-to-board 3/32” crimp terminal **Part #: 50011-8100** AMP 1.0 [0.039] FPC connector (surface mount) **Part #: 1-487951-4**

- end -

Appendix II - Company Directory

Company Name	*Contact Information*
3M - Industrial Tape & Specialities Division [USA]	Tel: 1-800-227-5085 Fax: 1-612-733-1771
Antenna Technology, Inc. [Taiwan]	Tel: +886-3-3223636-8 Fax: +886-3-3223639
ARDIS	Tel: 1-800-494-1732 Tel: 1-847-913-1215 Fax: 1-847-913-1453
Austin Antenna [USA]	Tel: 1-603-335-6339 Fax: 1-603-335-1756
Huber & Suner [USA]	Tel: 1-802-878-0555 Fax: 1-802-878-9880
Huber & Suner [Canada]	Tel: 1-800-627-2212 Tel: 1-613-596-6646 Fax: 1-613-596-3001
Larsen [USA]	Tel: 1-800-663-6734 Tel: 1-604-299-8517 Fax: 1-604-299-4191
M/ACOM [USA]	Tel: 1-617-890-4750 Fax: 1-617-672-1010
Molex Canada [Canada]	Tel: 1-416-292-1444 Fax: 1-416-292-2922

Index

N

O

P

R

S

T