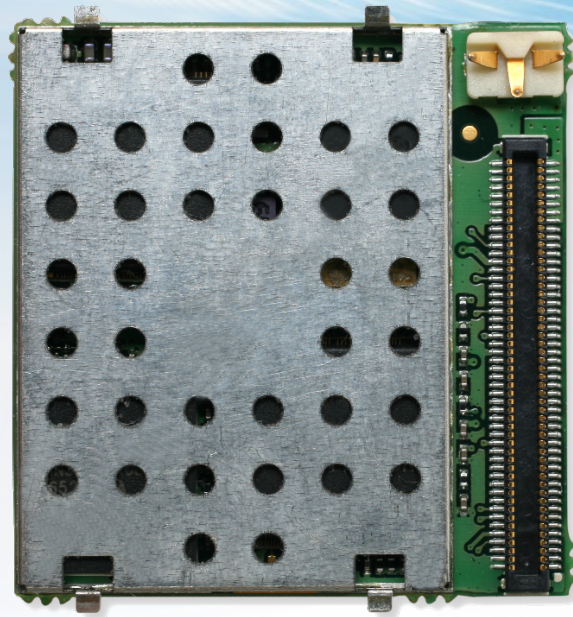GSM030XIG002

Enabler IIIG

Integration Guide

General

TERMS OF USE OF NEW MATERIALS - PLEASE READ CAREFULLY

From time to time, Novatel Wireless, in its sole discretion, may make available for download on its website (www.novatelwireless.com), or may transmit via mail or email, updates or upgrades to, or new releases of, the firmware, software or documentation for its products (collectively, 'New Materials'). Use of such New Materials is subject to the terms and conditions set forth below, and may be subject to additional terms and conditions as set forth in Novatel Wireless's Technical Support Policy (posted on its website) and/or any written agreement between the user and Novatel Wireless.

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Warranty Information

[Revised: 11/11/2010]

This warranty applies to (a) products sold directly by Novatel Wireless M2M, unless a different warranty is specified in a written agreement between Novatel Wireless M2M and the purchaser; and (b) products sold to end users through a distributor authorized by Novatel Wireless M2M, but only where the authorized distributor does not provide a separate warranty on such products, and Novatel Wireless M2M has agreed to provide this warranty to such end users. If you purchased the product from an authorized distributor, please check whether this warranty from Novatel Wireless M2M, or a separate warranty from the distributor, applies to your purchase. This warranty does not apply to any (i) accessories or batteries for the products; or (ii) demonstration samples or prototypes of the products. Unless otherwise provided in a written agreement between Novatel Wireless M2M and the purchaser, all such accessories, batteries, samples or prototypes are provided by Novatel Wireless M2M AS IS without any warranty of any kind.

Novatel Wireless M2M warrants to the original purchaser of the product from Novatel Wireless M2M or its authorized distributor (as applicable) that, for a period of one (1) year from the date of shipment of the product from Novatel Wireless M2M, the product hardware will be substantially free from defects in material or workmanship under normal operation, and the product firmware will perform substantially in accordance with the product documentation provided by Novatel Wireless M2M. Novatel Wireless M2M does not warrant that (a) the product hardware or firmware will meet the purchaser's requirements; (b) the operation of the product hardware or firmware will be uninterrupted or error-free; or (c) the product, when integrated in, or combined with, other products or software not supplied by Novatel Wireless M2M, will continue to perform substantially in accordance with the product documentation. This limited warranty is for the benefit of the original purchaser, and is not transferable.

During the warranty period, Novatel Wireless M2M, at its expense and in its sole discretion, will repair the product, or replace the product with a corresponding or equivalent product, if it is determined to have a covered defect, provided that the purchaser first notifies Novatel Wireless M2M (directly or through its authorized distributor from which the product was purchased) of any such defect, furnishes Novatel Wireless M2M with a proof of purchase (if required), requests and obtains a return merchandize authorization (RMA) number from Novatel Wireless M2M, and returns the product under that RMA to Novatel Wireless M2M (or, at Novatel Wireless M2M's option, to its authorized distributor), with the shipping charges being prepaid by purchaser. If, upon reasonable examination of the returned product, Novatel Wireless M2M does not substantiate the defect claimed by purchaser, or determines that the defect is not covered under this limited warranty, Novatel Wireless M2M will not be required to repair or replace the product, but may instead reship the product to the purchaser (or, at Novatel Wireless M2M's option, to its authorized distributor where the product can be made

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available to purchaser), in which case the purchaser shall be responsible for paying Novatel Wireless M2M's cost for reshipping the product to purchaser (or to Novatel Wireless M2M's authorized distributor), and Novatel Wireless M2M's usual charges for unpacking, testing, and repacking the product for reshipment to purchaser (or to Novatel Wireless M2M's authorized distributor).Purchaser shall bear the risk of loss or damage in transit to any product returned by purchaser to Novatel Wireless M2M, or any returned product not found to be defective or covered under this warranty, and reshipped by Novatel Wireless M2M to purchaser (or to Novatel Wireless M2M's authorized distributor). In the event Novatel Wireless M2M repairs or replaces a defective product covered by this limited warranty, the repaired or replacement product will be covered under this limited warranty for the remainder of the original warranty period on the defective product, or a period of ninety (90) days, whichever is longer. If Novatel Wireless M2M is unable to repair or replace a defective product covered by this limited warranty, Novatel Wireless M2M will provide to purchaser a credit or a refund (at Novatel Wireless M2M's option) of the original purchase price (excluding taxes and shipping charges). Any returned and replaced product, or any product for which Novatel Wireless M2M has furnished a credit or a refund, becomes the property of Novatel Wireless M2M.

Novatel Wireless M2M shall not have any obligation to provide any firmware bug fixes, upgrades or new releases except as may be necessary to correct any covered defect of which purchaser notifies Novatel Wireless M2M in writing during the warranty period. Novatel Wireless M2M, from time to time and in its sole discretion, may make available for download on its website (www.novatelwireless.com), or may provide via email, certain firmware bug fixes, upgrades or new releases for the product. Download and use of any such bug fixes, upgrades or new releases is subject to all of the applicable terms and conditions of Novatel Wireless M2M's technical support policy as posted and updated on its website.

Novatel Wireless M2M shall have no obligation under this limited warranty for (a) normal wear and tear; (b) the cost of procurement of substitute products; or (c) any defect that is (i) discovered by purchaser during the warranty period but for which purchaser does not request an RMA number from Novatel Wireless M2M, as required above, until after the end of the warranty period, (ii) caused by any accident, misuse, abuse, improper installation, handling or testing, or unauthorized repair or modification of the product, (iii) caused by use of any materials not supplied by Novatel Wireless M2M, or by use of the product other than in accordance with its documentation, or (iv) the result of electrostatic discharge, electrical surge, fire, flood or similar causes.

The purchaser (or its customers, as applicable) shall be solely responsible for the proper configuration, testing and verification of the Novatel Wireless M2M product prior to deployment in the field, and for ensuring that any end user product or system into which the Novatel Wireless M2M product is integrated or incorporated operates as intended and meets the requirements of purchaser (or its customers). Novatel Wireless M2M shall have no responsibility whatsoever for the integration, configuration, testing, verification, installation, upgrade, support or maintenance of any such end user product or system, or for any liabilities, damages, costs or expenses associated therewith.

Novatel Wireless M2M'S SOLE RESPONSIBILITY AND PURCHASER'S SOLE REMEDY UNDER THIS LIMITED WARRANTY SHALL BE FOR Novatel Wireless M2M TO REPAIR OR REPLACE THE PRODUCT (OR IF REPAIR OR REPLACEMENT IS NOT POSSIBLE, PROVIDE A CREDIT OR REFUND OF THE PURCHASE PRICE) AS PROVIDED ABOVE. Novatel Wireless M2M EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, SATISFACTORY PERFORMANCE AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL Novatel Wireless M2M BE LIABLE FOR ANY INDIRECT, SPECIAL, EXEMPLARY, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOSS OR INTERRUPTION OF USE, DATA, REVENUES OR PROFITS) RESULTING FROM A BREACH OF THIS WARRANTY OR BASED ON ANY OTHER LEGAL THEORY, EVEN IF Novatel Wireless M2M HAS BEEN ADVISED OF THE POSSIBILITY OR LIKELIHOOD OF SUCH DAMAGES.

Some jurisdictions may require a longer warranty period than specified above and, accordingly, for products sold in those jurisdictions the applicable warranty period shall be extended as required under the laws of those jurisdictions. Furthermore, some jurisdictions may not allow the disclaimer of implied warranties or the exclusion or limitation of incidental or consequential damages, so the above disclaimer, limitation or exclusion may not apply to products sold in those jurisdictions. This limited warranty gives the purchaser specific legal rights and the purchaser may have other legal rights that vary from jurisdiction to jurisdiction.

This limited warranty shall be governed by the laws of the State of Texas, United States of America, without regard to conflict of laws principles. This limited warranty shall not be governed in any respect by the United Nations Convention on Contracts for the International Sale of Goods.

Regulatory Compliance

This section summarizes the responsibilities and actions required of manufacturers and integrators who incorporate OEM versions of the Novatel Wireless M2M Enabler IIIG module into their products. In certain situations and applications, these products will require additional FCC, CE, GCF, PTCRB or other regulatory approvals prior to sale or operation. Appropriate instructions, documentation and labels are required for all products. For more information concerning regulatory requirements, please contact Novatel Wireless M2M.

GCF/PTCRB Approval (Formerly FTA)

The Novatel Wireless M2M Enabler IIIG module is type approved in accordance with the requirements of and through the procedures set forth by the GSM industry association. The relevant conformance specification is 3GPP TS 51010-1. Any OEM changes in the SIM interface, antenna port, software or the physical makeup of the unit may require an incremental FTA to ensure continued compliance with the above-mentioned standard. For more information concerning type approval, please contact Novatel Wireless M2M.

FCC Certification

Novatel Wireless M2M certifies that the Novatel Wireless M2M Enabler IIIG 850/900/1800/1900 MHz GSM Radio Module (FCC ID: MIVGSM0308) complies with the RF requirements applicable to broadband PCS equipment operating under the authority of 47 CFR Part 24, Subpart E and Part 22 of the FCC Rules and Regulations. This certification is contingent upon installation, operation and use of the Novatel Wireless M2M Enabler IIIG module and its host product in accordance with all instructions provided to both the OEM and end user. When installed and operated in a manner consistent with the instructions provided, the Novatel Wireless M2M Enabler IIIG module meets the maximum permissible exposure (MPE) limits for general population / uncontrolled exposure at defined in Section 1.1310 of the FCC Rules and Regulations.

The Enabler IIIG modem is designed for use in a variety of host units, "enabling" the host platform to perform wireless data communications. However, there are certain criteria relative to integrating the modem into a host platform such as a PC, laptop, handheld, monitor and control unit, etc. that must be considered to ensure continued compliance with FCC compliance requirements. Please follow this next section when integration this modem to ensure compliance with the FCC and IC rules.

M2M Module Installation and Collocation Guidelines

FCC and IC Approval Process for Host Devices

FCC and IC Integrations are covered through two possible approaches.

1) New grant

Labeling: A single 'New' FCC ID covers the host and the integrated module.

In this approach the host manufacturer will have the system (host and module) evaluated to all the applicable FCC requirements. A new FCC ID is obtained to cover this assessment. This option is the responsibility of the host manufacturer.

2) Class I or a Class II permissive change

Labeling: The Enfora/Novatel Wireless FCC ID appears on the host device.

This section provides module and antenna installation guidelines for host devices to be authorized for use with the (M2M module here) module through the FCC Class I or Class II Permissive Change process. As the grantee Enfora/Novatel Wireless is responsible for all integrations and must be consulted on all regulatory matters involving the GSM0308.

The module was originally granted by the FCC as a single modular approval. The technical specifications of the integrations will determine the scope of work to cover the integrations.

1) The M2M module can be installed as a standalone transmitter in devices as a Class I permissive change meeting the following conditions:

> a. >20cm separation distance is provided between the M2M transmitting antenna and the end user at all times.

> b. All other intentional radiators within the host device must be evaluated:

>> i. An antenna location diagram for the host device must be provided, showing locations of all transmitting antennas and the separation distance of other transmitting antennas from the M2M antenna

>> ii. A list of FCC ID's for all collocated transmitters must be provided.

>> iii. Datasheets for all collocated transmitting antenna(s) must be provided, showing manufacturer part number, and peak gain (dBi)

> c. The host PCB trace that carries the RF from the module to the external antenna connector must be evaluated against the design guides. Strict adherence to the design parameters in the design guides must be observed for a Class I permissive change to be considered.

> d. The antenna gain cannot exceed the following to qualify as a Class I permissive change:

>> i. 850MHz: 4.5dBi

ii. 1900MHz: 2.0dBi

e. If the M2M modem is required to provide voice support the design must be evaluated by Novatel Wireless.

f. The FCC and Industry Canada IDs must be permanently affixed on the exterior of the notebook or readily accessible under a panel or battery pack of the host device that cannot be separated from the host device itself.

  i. The label must state:

    a. This device contains FCC ID: MIVGSM0308

    b. This device contains IC: 4160A-GSM0308

g. The user manual/installation guide must give clear instructions regarding the proper installation and use to ensure compliance with FCC/IC RF Exposure guidelines, and also include appropriate caution and warning statements and information

2) The M2M module can be installed as a standalone transmitter in host devices as a Class II permissive change meeting the following conditions. (Standalone is defined as a single transmitter transmitting as opposed to 2 or more transmitters transmitting simultaneously.)

a. ≤20cm separation distance is provided between the transmitting antenna and the end user. This will trigger a SAR measurement or evaluation. The OEM integrator is responsible to design the product to comply with RF exposure, and must work with Novatel Wireless (the grantee) to satisfy FCC/IC SAR requirements.

b. If the device does not meet the criteria in item #1 for a Class I permissive change then additional testing with an application to the FCC will be required.

c. Once the Class II permissive change has been completed the FCC and Industry Canada IDs must be permanently affixed on the exterior of the notebook or readily accessible under a panel or battery pack of the host device that cannot be separated from the host device itself.

  i. The label must state:

    a. This device contains FCC ID: MIVGSM0308

    b. This device contains IC: 4160A-GSM0308

d. The user manual/installation guide must give clear instructions regarding the proper installation and use to ensure compliance with RF Exposure guidelines.

Note: The host manufacturer is responsible for all standalone regulatory requirements prior to the integration of the M2M module (i.e. FCC Part 15 for unintentional radiators).

FCC Notice to Users

Novatel Wireless M2M has not approved any changes or modifications to this device by the user. Any changes or modifications could void the users authority to operate the device. See 47 CFR Sec. 15.21. The device complies with part 15 of the 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. See 47 CFR Sec. 15.19.

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 instructions, may cause harmful interference to radio communications. However, there is no guarantee 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.

This device complies with Part 15 of the 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.

Refer to the following for FCC Regulations:

Internet: http://www.fcc.gov/

- FCC Rules, Part 24
    - 47 CFR Subpart E--Broadband PCS
    - 47 CFR § 24.52, sections 1.1307(b), 2.1091, and 2.1093
- FCC Rules, Part 22 for GSM 850
- FCC Rules, Part 15
- FCC Rules, Part 2
    - Subpart J--Equipment Authorization Procedures
    - Section 2.925

FCC Office of Engineering and Technology (OET)

Internet: http://www.fcc.gov.oet/

- Bulletin Number 65 "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields"
- Supplement C "Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Exposure to Radio Frequency Emissions"

CE Marking - R&TTE Directive

The Enabler IIIG module have been tested and certified to comply with the requirements of the European Directive 1999/5/EC, the R&TTE Directive. The modules are certified directly against Article 3.2 of the directive for Radio transceiver aspect. The modules are not directly certified against Article 3.1a (Safety) and 3.1b (EMC), but are shown to be in compliance through testing on a typical integrated device utilizing the module. The module is marked with the CE marked and the notified body number of the reviewing organization as is shown below.

CE0889

It is the responsibility of the integrator to ensure that the device incorporating the Enabler IIIG module is in compliance with the requirements of Article 3.1a (Safety) and 3.1b (EMC), as well as ensuring that the integrated device remains in compliance with the requirements of Article 3.2 of the directive.

Regulatory Requirements for Other Countries

In most other countries there are similar rules and regulations that may need to be met for importing the Novatel Wireless M2M Enabler IIIG module and for placing it on the market in the integrated device. Each country may require a different mark of approval as an acceptance requirement. For each of these cases the country should identified, and the appropriate steps should be taken to meet the requirements set forth in the intended market.

Industry Canada

Refer to the following for Industry Canada Regulations:

- RSS-132
- RSS-133
- ICES-003

ROHS Compliance

As a part of Novatel Wireless M2M's corporate policy of environmental protection, Novatel Wireless M2M takes every step to ensure that the Enabler IIIG modules are designed and manufactured to comply to the European Union Directive 2002/95/EC for the Restriction of Hazardous Substances (RoHS).

Environmental Regulations

Refer to the following for Environmental Regulations:

- National Environmental Policy Act (NEPA) of 1969 (Part 1, Subpart 1)

Mechanical Specifications

Refer to the following for RF and EMI Specifications:

- ASTM D999
- ASTM D775
- IEC 68-2-27
- Bellcore Gr-63-CORE
- ETS 300 019-1-1 Class 1.2
- ETS 300 019-1-2 Class 2.1
- ETS 300 019-1-3 Class 3.1

RF And EMI Specifications

Refer to the following for RF and EMI Specifications:

- ETSI Standards
- EN 61000-4-6
- EN 61000-4-3
- 3GPP TS 51.010-1, Section 12.2
- EN 55022 Class B

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References

Refer to the following sources for more information on the Enabler IIIG:

Manuals

- GSM0308AT001 - Novatel Wireless M2M GSM/GPRS OEM Module AT Command Set Reference
- GSM0308UG001 - Novatel Wireless M2M GSM-GPRS Family API Reference
- GSM0308SD001 - Enabler IIIG - SDK Guide

Application Notes

- GSM0000AN001 - Enabler-G PPP Configuration for Windows 98
- GSM0000AN002 - Enabler-G PPP Configuration for Windows 2000
- GSM0000AN003 - Enabler-G Data Circuit Switched Call Configuration and Use
- GSM0000AN004 - Enabler-G SMS Configuration and Use
- GSM0000AN005 - Enabler-G Automated Network Connection Configuration and Use
- GSM0000AN006 - Enabler-G Module Status Query
- GSM0000AN007 - Enabler-G Status Reporting
- GSM0000AN008 - Enabler-G PPP Configuration for Windows XP
- GSM0000AN009 - Dynamic IP Assignment Support
- GSM0000AN010 - Enabler-G PPP Configuration for PocketPC 2002
- GSM0000AN011 - PAD Configuration and Use
- GSM0000AN012 - Network Transparency Configuration for PAD
- GSM0000AN013 - Enabler-G Sleep Mode Configuration and Use
- GSM0000AN014 - Anytime PPP API Access
- GSM0000AN015 - Event Monitor and Reporting Overview
- GSM0000AN016 - How to Send SMS Messages to an E-Mail Address
- GSM0000AN017 - SMTP Mail Access via TCP PAD
- GSM0000AN018 - USNO NTP Network Time Service TCP PAD

Technical Notes

- GSM0000TN001 - Enabler-G Firmware Upgrade
- GSM0000TN002 - Enabler-G PPP Negotiation Sequence
- GSM0000TN006 - UDP Wakeup Message Header Decoding
- GSM0000TN008 - Enabler Power Supply Requirements
- GSM0000TN009 - Server Application Design Considerations for Dynamic IP
- GSM0000TN012 – Enabler IIIG Engineering Mode Command Reference
- GSM0000TN013 – Enabler IIIG and IIE CMUX Description

White Papers

- GSM0000WP001 - Enabler-G Differentiation Features

GSM Device Specifications

- 3GPP TS 51010-1 (850, 900,1800,1900 MHz devices)

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To view the latest release, go to: http://www.3gpp.org/ftp/Specs/html-info/51010-1.htm

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Important Safety Information

The following information applies to the devices described in this manual. Always observe all standard and accepted safety precautions and guidelines when handling any electrical device.

- Save this manual: it contains important safety information and operating instructions.
- Do not expose the Novatel Wireless M2M Enabler IIIG product to open flames.
- Ensure that liquids do not spill onto the devices.
- Do not attempt to disassemble the product: Doing so will void the warranty. With the exception of the Subscriber Identification Module (SIM), this product does not contain consumer-serviceable components.

Disclaimer

The information and instructions contained within this publication comply with all FCC, GCF, PTCRB, R&TTE, IMEI and other applicable codes that are in effect at the time of publication. Novatel Wireless M2M disclaims all responsibility for any act or omissions, or for breach of law, code or regulation, including local or state codes, performed by a third party.

Novatel Wireless M2M strongly recommends that all installations, hookups, transmissions, etc., be performed by persons who are experienced in the fields of radio frequency technologies. Novatel Wireless M2M acknowledges that the installation, setup and transmission guidelines contained within this publication are guidelines, and that each installation may have variables outside of the guidelines contained herein. Said variables must be taken into consideration when installing or using the product, and Novatel Wireless M2M shall not be responsible for installations or transmissions that fall outside of the parameters set forth in this publication.

Novatel Wireless M2M shall not be liable for consequential or incidental damages, injury to any person or property, anticipated or lost profits, loss of time, or other losses incurred by Customer or any third party in connection with the installation of the Products or Customer's failure to comply with the information and instructions contained herein.

 Warning: The Enabler IIIG platform is designed with features to support a robust connection. There are instances where the module performance is beyond the control of the intended design. Integrated designs that require 24 by 7 operation must implement power control via an external circuit or by implementing power management as specified within this design guide

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Introduction

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Novatel Wireless M2M Enabler IIIG modem is a compact, wireless OEM module that uses the Global System for Mobile Communications (GSM) and General Packet Radio Service (GPRS) international communications standard to provide two-way wireless capabilities via GSM services. The Novatel Wireless M2M Enabler IIIG module is a fully Type-approved GSM/GPRS device, enabling application-specific, two-way communication and control.

This document defines the electrical, mechanical, and software interfaces of the Enabler IIIG modem, and provides detailed technical information about streamlining hardware and system integration.

Technical Specifications

Housing

- Size (L x W x H): 28 x 27 x 2.5 mm
- Weight: < 4.2g w/ SIM Carrier / <3.6g w/o SIM Carrier
- RF Connector: MCD Coaxial or Board-to-Board Compressor

Radio

- Air Interface: GSM/GPRS
- Frequency Bands: 850/900 MHz - Class 4 (2 W) 1800/1900 MHz - Class 1 (1 W)
- Sensitivity: -106 dBm (Typical)
- Peak Downlink Speed: 85.6 kbps
- Peak Uplink Speed: 42.8 kbps

SIM Access

- Remote SIM: 1.8/3 V
- Opt Integrated SIM: Yes, Full-Size

Functionality

- Voice: FR, EFR, HR & AMR
- SMS: Text, PDU, MO/MT, Cell Broadcast

Environment

- Operating: -30°C to 85°C
- Compliant: -20°C to 60°C
- Storage: -40°C to 85°C
- Humidity: Up to 95% Non-Condensing

Power

- Operating Voltage: 3.3 - 4.4 V DC

Part Numbers

- Without SIM Carrier: GSM0308-10 (B2B RF), GSM0308-70 (Micro-Coaxial)
- With SIM Carrier: GSM0308-11 (B2B RF), GSM0308-71 (Micro-Coaxial)

Interface

- Host Protocols: AT Commands, UDP API, CMUX, PPP
- Internal Protocols: PPP, UDP API, TCP API, UDP and TCP (PAD)
- Command Protocol: Novatel Wireless M2M Packet API, GSM AT Command Set
- GSM/GPRS SMS Protocol: MO, MT, CB, Text and PDU Modes
- Packet Data Transfer Protocol: GPRS Release 97 and 99
- Coding Schemes: CS1-CS4
- Multi-Slot Capability: MS10 (4RX/2TX) (Max 5 Slots)
- Packet Channel Support PBCCH/PCCCH
- API Control/Status: AT Commands, UDP API, TCP API, AT Commands Over SMS
- Physical Interface: 1 serial (primaryDefault rate auto baud), I USB (debug) MCSI (PCM Audio Only) UART
- Peripheral Interface: 8 Programmable I/O (Expandable to 20), 1 Analog Input, 3 Audio (1 Digital Audio)
- Data Input/Output : 100-Position 0.4mm Pitch Connector
- Primary Serial Port: V.24 Portocol, 1.8V Levels, Full 9-Pin, UART Implementation
- USB Port: USB Debug Only (Novatel Wireless M2M Use Only)
- GPIO: Up to 20 GPIO
- Audio: Digital Audio via MCSI Port
- Voice: Supports 4 Vocoder Modes: FR, EFR, HR, and AMR
- Speech Codec EFR, FR, HR, AMR
- Antenna Interface: Ultra-Miniature Coaxial Interconnect (MCD) or B2B Spring Contact
- Command Protocol: Novatel Wireless M2M Packet
- Subscriber Identification Module (SIM): Optional 1.8/3 V Mini-SIM carrier and interface on board with SIM detect
- Optional Remote SIM: Accessible via the 100-pin connector
- Voltage Backup: Pin available to maintain RTC
- Reference Clock: 32 KHz & 13 MHz. Output reference clocks (via 100-pin connector)
- ADC: 1 ADC port

Certifications

Audio Features

- Handset Microphone Biasing:
- Headset Microphone Biasing
- Headset Plug/Unplug Detection
- Headset Hook Detection (Call answer/end button on equipped Headset microphone device)
- Handset earphone outputs (EARP, EARN pins)
- High-output dynamic differential Earphone mode (uses Headset outputs)
- Pop Noise attenuation circuitry implemented for all single-ended output stages
- Handset microphone input (MICIN, MICIP pins)
- Headset microphone input (HSMIC pin)
- Headset 32 stereo outputs (HSOL, HSOR pins)

Packet Data Transfer

- Operating: -30°C to 85°C
- Compliant: -20°C to 60°C
- Storage: -40°C to 85°C
- Humidity: Up to 95% Non-Condensing

- FCC: Parts 15, 22, & 24
- GCF: Version 3.27.0
- PTCRB: Version 5.6
- CE: Yes
- Industry Canada: RSS-210, 132, 133
- RoHS Compliant: Yes

Typical Usage

The following applications can use the Novatel Wireless M2M Enabler IIIG module for transmitting/receiving data/voice:

- Automated Meter Reading (AMR)
- Point of Sale Applications (POS)
- E-mail and Internet access
- Automated Vehicle Location (AVL)
- Machine-to-Machine communication (M2M)
- Telematics
- Telemetry
- Wireless Security
- Smart Phones
- Telemedicine

Contacting Novatel Wireless M2M

For technical support and customer service dealing with the modem itself, contact the company where you purchased the product. If you purchased the product directly from Novatel Wireless M2M, visit the SUPPORT page on the Novatel Wireless M2M web site: www.novatelwireless.com

2

Module Power

Typical Operating Power

Typical Operating Power

GSM Operation	
GSM 850/900 (1 RX/1 TX, full power)	250 mA average, 1.6 A peak
GSM 1800 (1 RX/1 TX, full power)	215 mA average, 1.3 A peak
GSM 1900 (1 RX/1 TX, full power)	204 mA average, 1.2 A peak
Idle	<2.5 mA Average in DFX 5
Shutdown	<50uA
	Vbat = 3.7V, Vbak=Vbat, current = 48uA
	Vbat = 3.7V, Vbak=0V, current = 45uA
	Vbat = 0V, Vbak=3.7V, current=6uA

GPRS Operating Power	
EGSM 850.900 (4 RX/1 TX, full power)	272 mA average, 1.6 A peak
EGSM 850/900 (2 RX/2 TX, full power)	420 mA average, 1.6 A peak
GSM 1800 (4 RX/1 TX, full power)	242 mA average, A peak
GSM 1800 (2 RX/2 TX, full power)	354 mA average, A peak
GSM 1900 (4 RX/1 TX, full power)	235 mA average, A peak
GSM 1900 (2 RX/2 TX, full power)	340 mA average, A peak
Idle	<2.5 mA average in DFX 5
Shutdown	<50 uA
	Vbat = 3.7V, Vbak=Vbar, current = 48uA
	Vbat = 3.7, Vbak=0V, current = 45uA
	Vbat = 0V, Vbak=3.7V, current = 6uA

GSM Transmit Power	
1800/1900 MHz	GSM Power Class 1 (30 dBm ⊕2 dB @ antenna connection)
850/900 MHz	GSM Power Class 4 (33 dBm ⊕2 dB @ antenna connection)

GSM/GPRS Receiver Sensitivity (Typical)	
1800/1900 MHz	<-106 dBm, GPRS Coding Scheme 1 (CS1)
850/900 MHz	<-106 dBm, GPRS Coding Scheme 1 (CS1)

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3

Physical Interfaces

1.0
SIDE OF SHIELD TO END-OF-TAB

1.0

0.6
PCB EDGE TO END-OF-TAB

DETAIL A: MOUNTING TABS

A

28.0

27.0

MODEM TOP

14.0

2.60

9.2

2.10

2.00

16.75

1.50

2.50 MAX

Figure 3-1 Front of Module (Board-to-Board RF Conn. Version)
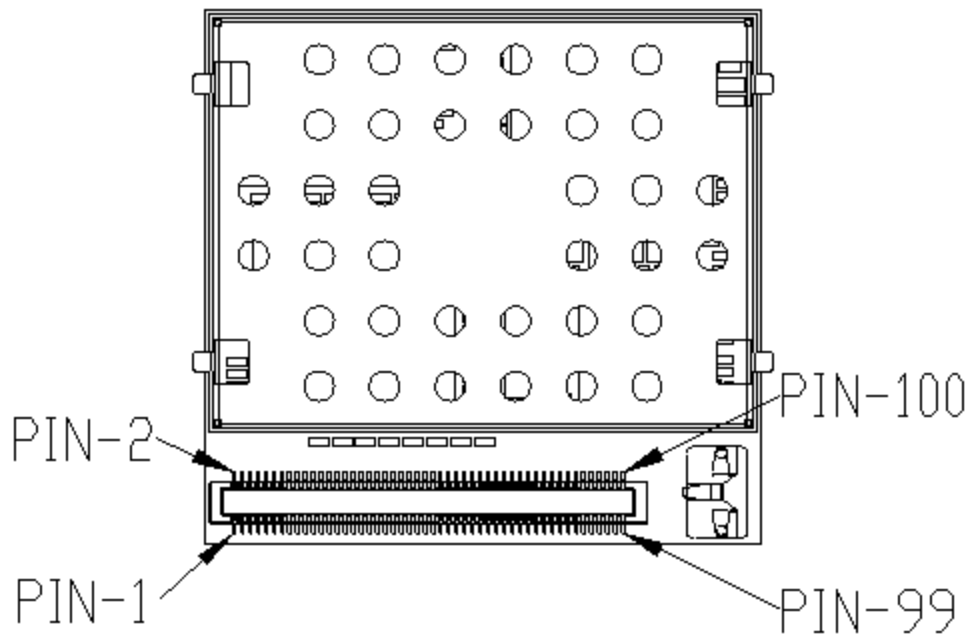
Figure 3-2 Pin 1 Reference, 100-Pin I/O Connector

1.0
SIDE OF SHIELD TO END-OF-TAB

1.0

0.6
PCB EDGE TO END-OF-TAB

DETAIL A MOUNTING TABS

A

28.0

MODEM TOP

27.0

14.0

2.60

9.21

1.50 (MATING
CONNECTOR SHOWN)

2.50 MAX

2.00

16.75

2.10

ALL DIMENSIONS ARE IN MILIMETERS
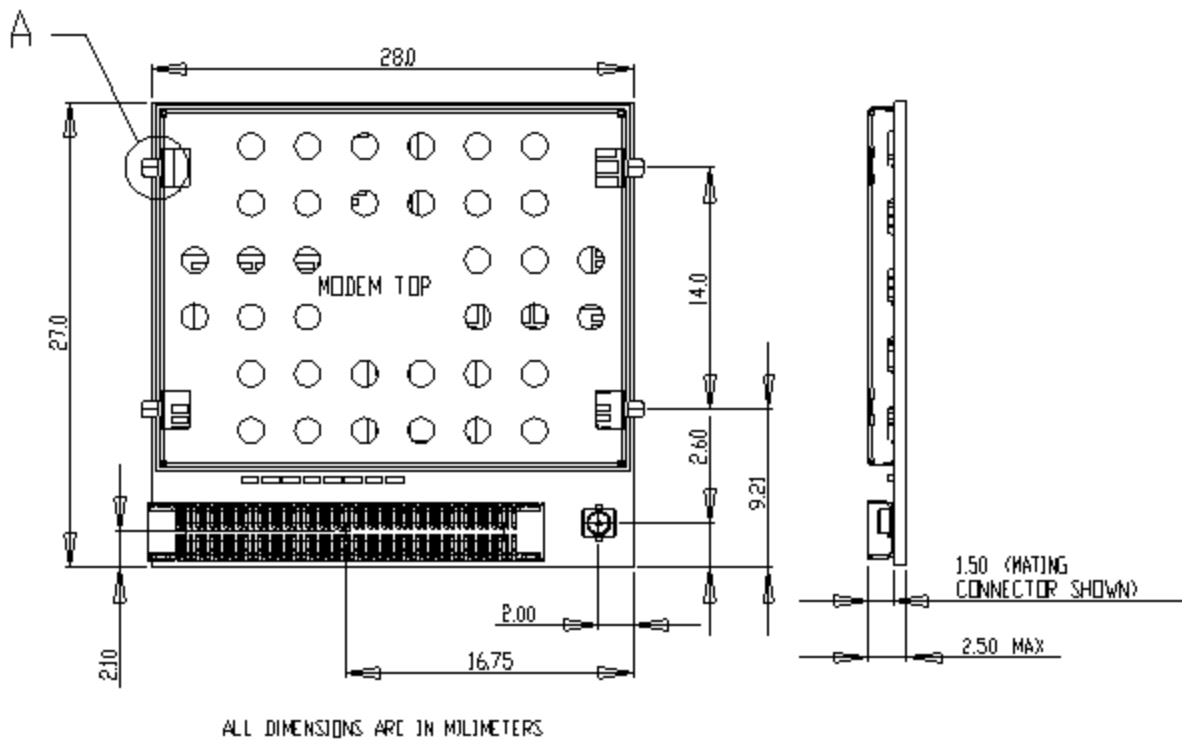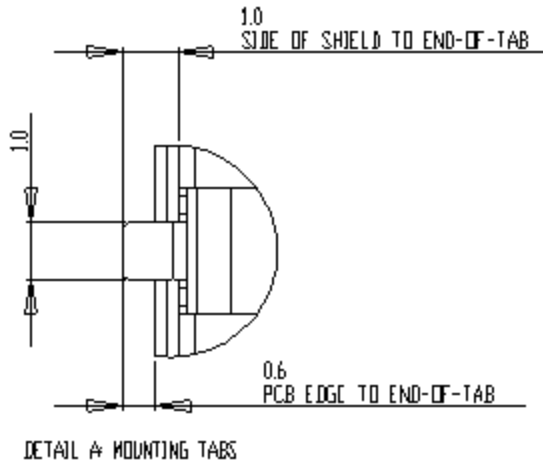
Figure 3-3 Front of Module (Coaxial RF Conn. Version)

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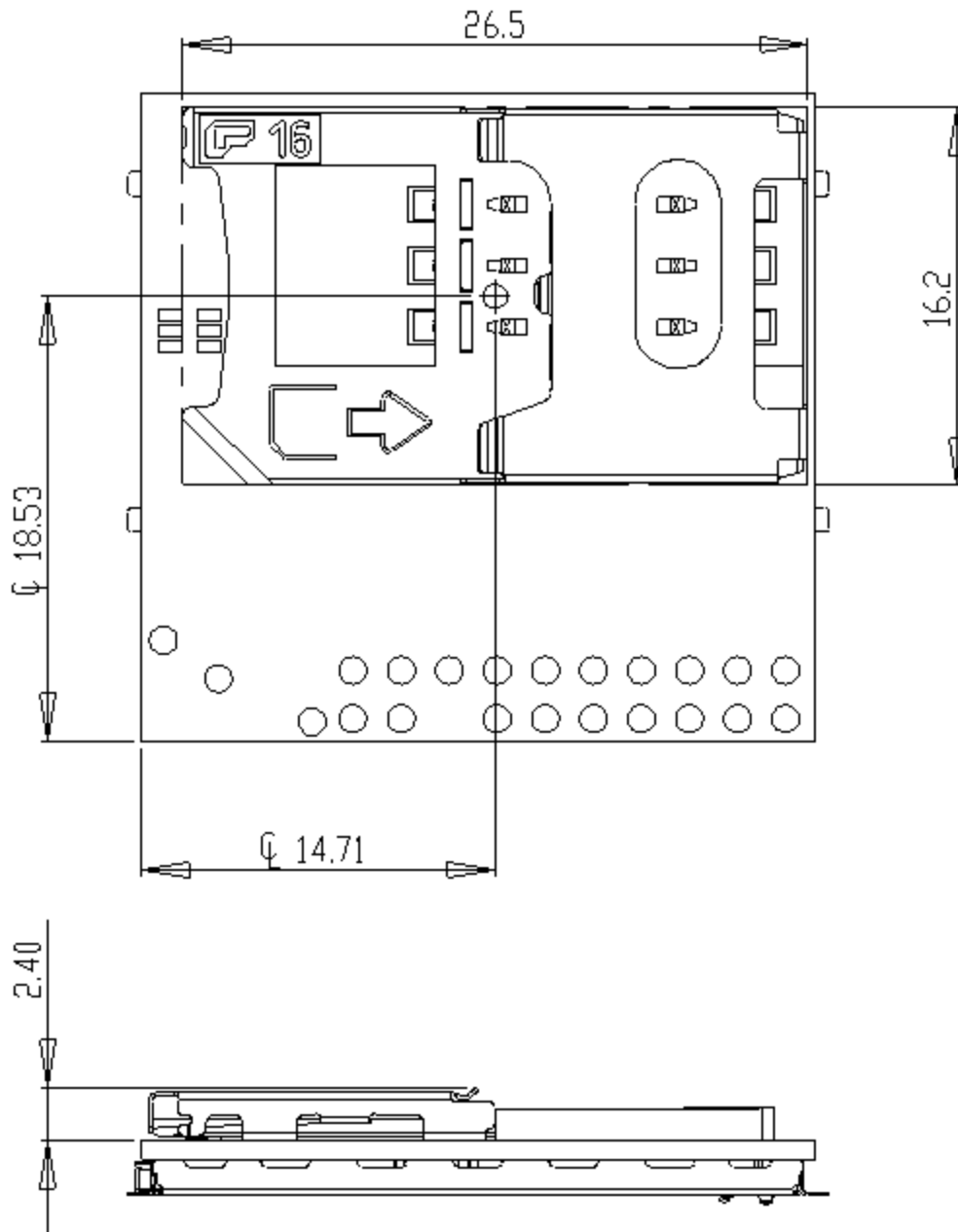
Figure 3-4 Back of Module (Option SIM Shown)

Module Mounting To Host Board (Reference)

The module provides mounting tabs that must be soldered to a PCB. These tabs provide circuit grounding for the module.

HOST BOARD LAYOUT
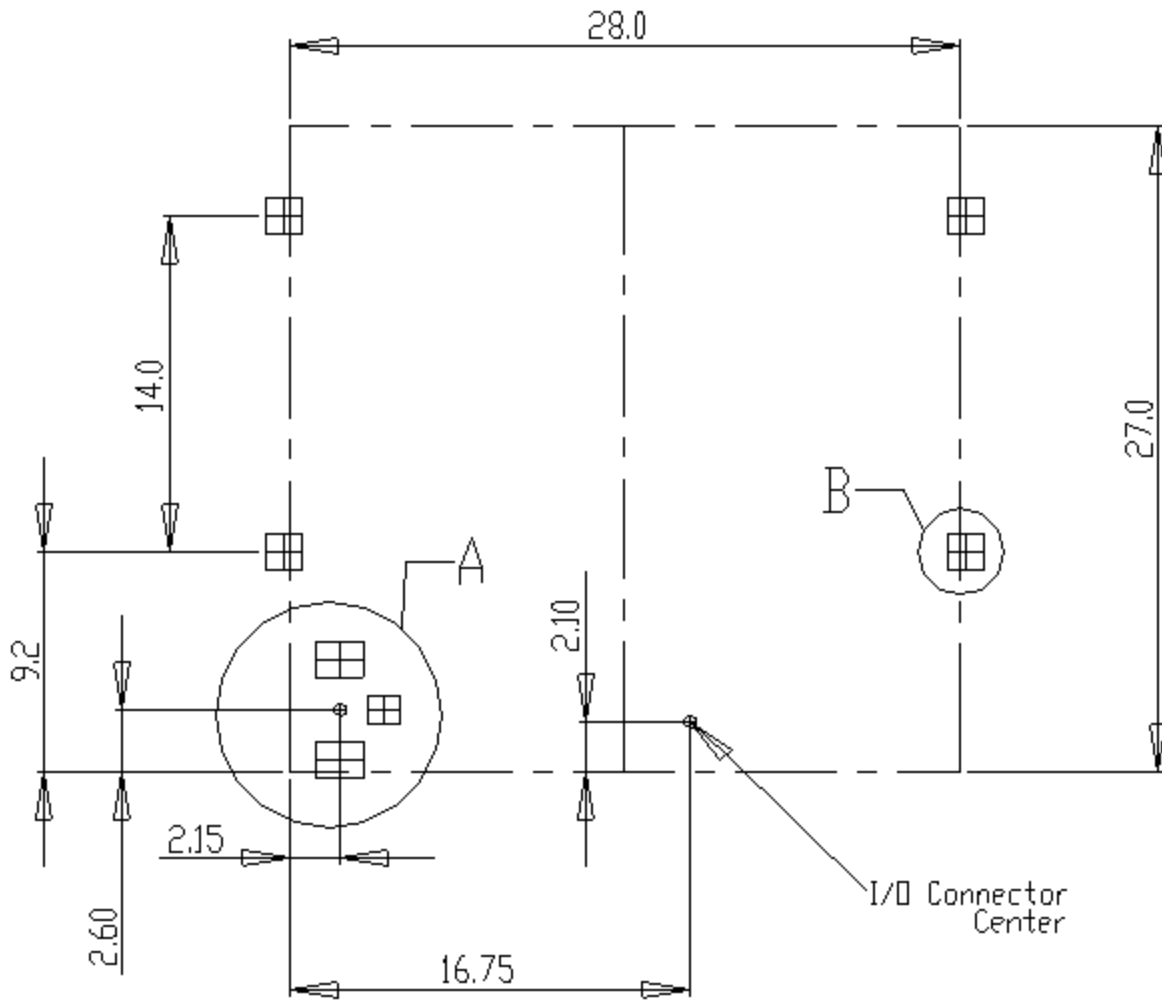
Figure 3-5 Module Mounting

BOARD-TO-BOARD
RF PADS ON HOST

2.00

1.50

GOLD PLATED
GROUND PAD
(2 PLACES)

1.4

CENTER REF.

GOLD PLATED
ANTENNA PAD

1.2

2.10

0.5

CLEAR OUT
AREA

1.80
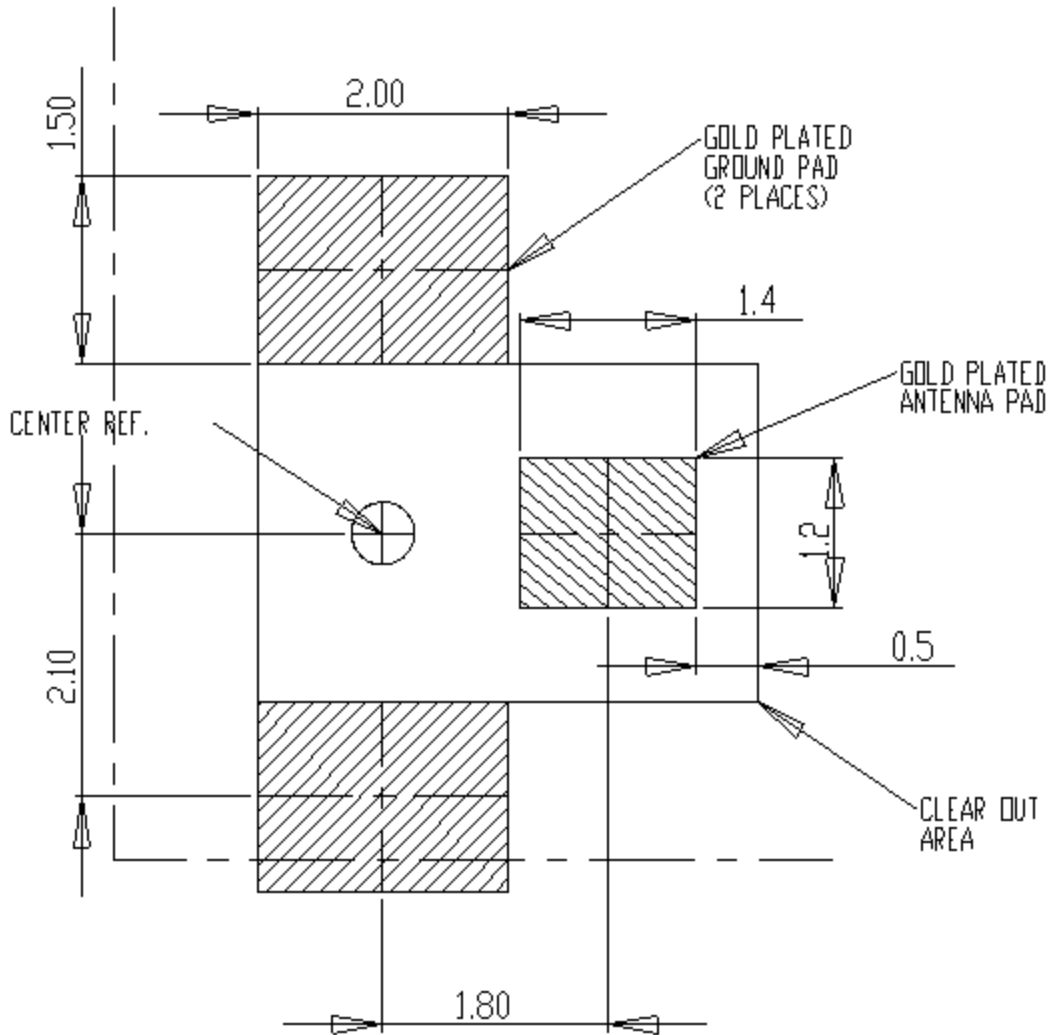
DETAIL A
SCALE 15 : 1

Figure 3-6 Host Pads for Board-To-Board RF Connector

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MODEM MOUNTING PADS
(4 PLACES)

EDGE OF MODEM

0.2

1.5

THERMAL RELIEF
SUGGESTED ON
MOUNTING PADS

1.5
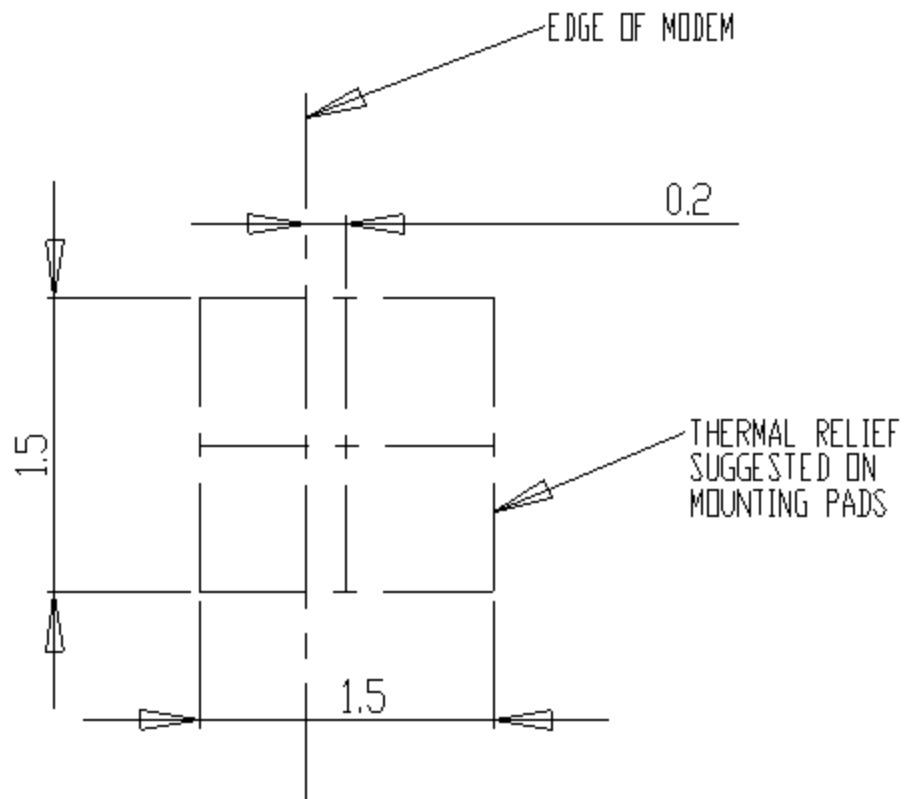
DETAIL B
SCALE 20 : 1

Figure 3-7 Modem Mounting Pads

Connectors

On The Modem: 100-Pin I/O Connector, Plug, SMT, Dual Row, 0.4 mm Pitch

Novatel Wireless M2M PN = CON-1040-0100

Molex PN = 55909-1074

On The Host: 100-Pin I/O Connector, Socket, SMT, Dual Row, 0.4 mm Pitch (Mate to module)

Novatel Wireless M2M PN = CON-1040-0101

Molex PN = 51338-1074

The mated height of the two connectors is 1.50 mm.

Connectors

The following sections describe connection options:

Coaxial Connector Option

On The Modem:

Sunridge MCD Series – Ultimate Miniature Coaxial Interconnect, 1.55mm Mated Height

Contact Sunridge for mating cable options:

Novatel Wireless M2M PN = CON-0009-0005

Sunridge PN = MCD-ST-00T

http://sunridgecorp.com/

Sunridge Corporation

2500 E. Foothill Blvd. Suite 107

Pasadena, CA 91107

U. S. A.

Tel: (626) 535-1780

Fax: (626) 535-1788

RF Board-to-Board Connector Option

On The Modem:

Novatel Wireless M2M PN = CON-0009-0006

Sunridge PN = MCE-15A-G01

On The Host PCB:

No connector required. See Figure for layout details.

I/O Connector Pin Assignments

The following table shows the pin assignments for the input/output connector.

Pin #		I/O	Description/Comments (Default Function / Secondary Function	Notes
1		P	VBUS	USB power
2		R	GND	System Ground
3		P	VBUS	USB power
4		R	GND	System Ground
5		I/O	USB_DP/RXD/	
MIC_R	5 V tolerant data plus pin in USB modes			
6		I	LED_B	LED B sink
7		I/O	USB_DM	5 V tolerant data minus pin in USB modes
8		I	RESERVED	RESERVED
9		I	ID_USB	USB connector identification
10		O	RESERVED	RESERVED
11	7	I	UART_RTS	Request to send
12		I/O	MCSI_RX/GPIO12	GPIO12 / MCSI Serial data input
13	8	O	UART_CTS	Clear to send
14		I/O	MCSI_CLK/GPIO9	GPIO9 / MCSI Serial Clock I/O
15	2	O	UART_RXD	Serial Data Output
16		I/O	MCSI_FSYNC/GPIO10	GPIO10 / MCSI Frame Synchronization I/O
17	4	I	UART_DTR	Data Terminal Ready
18		I/O	MCSI_TX / GPIO11	GPIO11 / MCSI Serial Data Output
19	1	O	UART_DCD	Data carrier detect
20		I/O	GPIO18	GPIO18
21	3	I	UART_TXD	Serial data input
22		I/O	GPIO15	GPIO15
23	9	O	UART_RING	Ring Indicate
24		I/O	GPIO16	GPIO16
25	6	O	UART_DSR	Data Set Ready
26		I/O	GPIO14	GPIO14
27		O	RESERVED	RESERVED
28		I/O	GPIO17	GPIO17
29		O	RESERVED	RESERVED
30		I/O	GPIO13	GPIO13
31		O	RESERVED	RESERVED
32		I/O	GPIO20	GPIO20
33		O	RESERVED	RESERVED

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Pin #		I/O	Description/Comments (Default Function / Secondary Function)	Notes
34		I/O	GPIO19	GPIO19
35		I	PWR_CTL	External switch-on event (ON Button) with 32-kHz de-bouncing
36		I	RESERVED	RESERVED
37		I	RESERVED	RESERVED
38		I	RESERVED	RESERVED
39		I	RESERVED	RESERVED
40		I	RESERVED	RESERVED
41		O	RESERVED	RESERVED
42			RESERVED	RESERVED
43			RESERVED	RESERVED
44			RESERVED	RESERVED
45			RESERVED	RESERVED
46			RESERVED	RESERVED
47		I	HST_DET	Headset Detect (if not used, can be left floating)
48		O	RESERVED	RESERVED
49		I	RESERVED	RESERVED
50			RESERVED	RESERVED
51			RESERVED	RESERVED
52			RESERVED	RESERVED
53		O	HSMICBIAS	Headset microphone bias
54		R	GND	System ground
55		I	HSMIC	Microphone input (Headset)
56		O	CLK32K_BUF	32.768 kHz out, only buffered by 10 kΩ resistor
57		O	HSOL	32 kΩ headset amplifier Left
58		I/O	GPIO_4	GPIO 4
59		O	HSOR	32 kΩ headset amplifier Right
60		I/O	GPIO_3	GPIO 3
61		O	HSOVMID	Headset output common mode
62		I/O	USB_BOOT/	
GPIO_2	GPIO 2			
63		O	MICBIAS	Microphone bias
64		I/O	GPIO_1	GPIO 1
65		I	MICIP	Microphone amplifier positive input (Handset)
66		I/O	GPIO_7	GPIO 7
67		I	MICIN	Microphone amplifier negative input (Handset
68		I/O	GPIO_5	GPIO 5
69		R	GND	System Ground

Pin #		I/O	Description/Comments (Default Function / Secondary Function	Notes
70		I/O	GPIO_6	GPIO 6
71		O	EARP	33 Ω or 120 Ω speaker amplifier (+) (Analog)
72		I/O	GPIO_8	GPIO 8
73		O	EARN	33 Ω or 120 Ω speaker amplifier (-) (Analog)
74		I	ADCIN4	10-bit A-to-D
75		R	GND	System Ground
76 (No Connect if onboard SIM holder is used)		PWR	VRSIM	Output voltage for SIM 1.8 V / 2.85 V
77		PWR	VRIO	1.8 V out – Reference for external level translation
78 (No Connect if onboard SIM holder is used)		O	SIM_CLK	SIM Card Reference clock
79			RESERVED	RESERVED
80 (No Connect if onboard SIM holder is used)		O	SIM_RST	SIM Card Reference clock
81			RESERVED	RESERVED
82 (No Connect if onboard SIM holder is used)		I/O	SIM_IO	SIM Card I/O Data
83		PWR	VBACKUP	Backup Battery Voltage
84 (No Connect if onboard SIM holder is used)		I	SIMDTC	SIM card insertion/extraction detect with 32-kHz debouncing. (If not used, tie to ground.)
85		P	VBAT	Power from Host
86		R	GND	System Ground
87		P	VBAT	Power from Host
88		R	GND	System Ground
89		P	VBAT	Power from Host
90		R	GND	System Ground
91		P	VBAT	Power from Host

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Pin #		I/O	Description/Comments (Default Function / Secondary Function	Notes
92		R	GND	System Ground
93		P	VBAT	Power from Host
94		R	GND	System Ground
95		P	VBAT	Power from Host
96		R	GND	System Ground
97		P	VBAT	Power from Host
98		R	GND	System Ground
99		P	VBAT	Power from Host
100		R	GND	System Ground

Circuit Protection

The module does not have any protection against ESD events or other excursions that exceed the specified operating parameters (other than very low level ESD protection within the module's integrated circuits).

Generally, you should add ESD protection (typically TVS/Transzorb devices) to all signals that leave the host board. This includes VBAT/VCC.

You can also add series resistors (typically 47) in series with data lines to limit the peak current during a voltage excursion.

Note: Do not add series resistance to the SIM electrical lines.

Minimum ESD Protection Levels	ESD/Input Voltage				
Pin #'s	ESD Test Method	Min	Nom/		
Avg	High/				
Peak	Units				
Pins 11 – 24, 26-34, 36, 38, 40, 42, 48, 50, 52, 58, 60, 62, 64, 66,68, 70, 72, 78, 80, 82	Human Body Model				
EIA/JEDEC22-A114-A	500			V	
	Charge Device Model				
EIA/JEDEC22-C101-A	200			V	
Pins (all VBUS/PWR), 5 – 10, 35, 37, 47, 49, 51, 52, 53, 55 – 57, 59, 61, 63, 65, 67	Human Body Model EIA/JEDEC22-A114-A	2000			V

Minimum ESD Protection Levels	ESD/Input Voltage				
	Charge Device Model EIA/JEDEC22-C101-A	500			V
RF Antenna	IEC 61000-4-2			8000	V

As the integrator, it is your responsibility to protect the Enabler IIIG module from electrical disturbances and excursions that exceed the specified operating parameters.

Antenna

The GSM0308/GSM0306 module has one RF antenna connection on the module. The connection is for the GSM section of the module.

Control Connector Signal Functions

Please note that we included the following descriptions to provide hardware-level definitions. In some cases, specific lines will have no firmware functionality implemented. We included information for each hardware-specific feature in the appropriate section.

Module Power (Pins 85, 87, 89, 91, 93, 95, 97, 99)

The Novatel Wireless M2M Enabler IIIG module uses a single voltage source of VCC=+3.3V to 4.5V. (The exact values of the uplink currents are shown in the tables in section 5.3.1.)

VBAT	Parameter/Conditions	Min	Typ	Max	Units
Main Battery Supply					
	Voltage In Regulation	3.3		4.5	Vdc
Peak Current	1000 Ω on Host at Module Connector				mA

> The uplink burst will cause strong ripple on the voltage lines and should be effectively filtered. We recommend that you place 1000 to 2000 μF of capacitance as close to the modem I/O connector as possible. Do not allow the input voltage level to drop below the minimum voltage rating under any circumstances, especially during the uplink burst period.

Power Control (Pin 35) - (PWR_CTL)

The input is equivalent to a "phone ON-button". A falling-edge on this Active-Low input will switch-ON the module or switch-OFF the module after a delay*. This input has a "weak pull-up" resistor inside the module. You can leave this input grounded if it does not require the RTC Sleep Function. If it requires RTC Sleep, then you must float the PWR_CTL line to allow the internal resistor to pull the line high.

Only an open collector/open drain device may control the Power Control signal. Driving the Power Control signal high may interfere with the normal operation of the modem. If driving from an external microprocessor, you can control the Power Control by driving the control pin low as an output, then changing the microprocessor's pin control to be an input (this will satisfy the high impedance requirement).

> The AT$OFFDLY Command controls the OFF Delay. A value of 0 disables the PWR_CTL line from turning the module off. 0 is the default value.
> To enable the module to switch-OFF via PWR_CTL, you must set AT$OFFDLY to a value other than 0. The valid range is 100 to 1000 milliseconds.

Turning On The Enabler IIIG

You must pull the PWR_CTL line on the Enabler IIIG LOW for at least 50mS (after applying and stabilizing Vbat) to turn it ON. Allow a minimum of 2 seconds for Vbat to stabilize before asserting the PWR_CTL signal to turn on the modem.

Do not use a pull-up resistor on the PWR_CTL line since the line is pulled up internal to the modem.

Turning Off The Enabler IIIG

To turn the Enabler IIIG off, apply either a low pulse on the PWR_CTL line, or use a software command (AT$OFF, see AT Command guide for further details).

Using The Power Control Signal

To power the module on/off with a switch:
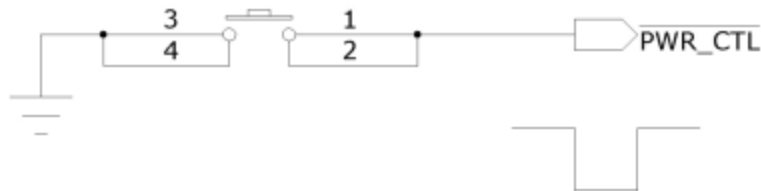
Figure 3-8 Power Control Switch

To control the PWR_CTL from microcontroller:
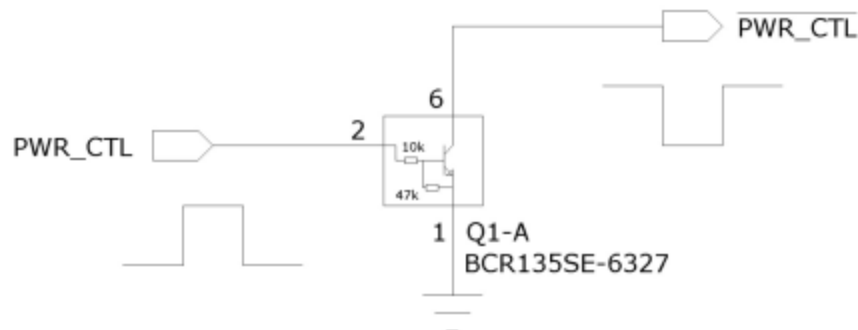
To connect the PWR_CTL to modem:

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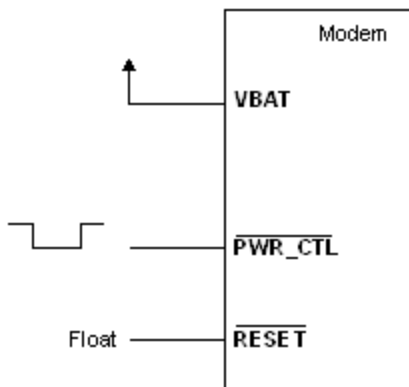
External Power Control Signal (no external processor) shows a typical connection to the Novatel Wireless M2M Enabler IIIG module in a machine-to-machine application using the external PWR_CTL signal (when there is not an external processor controlling the power on/off states). The RTC deep sleep functions will NOT function since the PWR_CTL pin is tied low, the processor will never stay in a "RTC Sleep" mode. To reset the module, the power (VBAT) must be cycled.
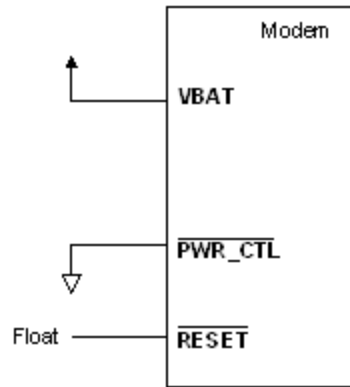
Figure 3-9 External Power Control Signal (no external processor)

The Power Control Signal (using external processor) figure shows a typical connection from an external processor to the Novatel Wireless M2M Enabler IIIG module using the external PWR_ CTL signal. The Novatel Wireless M2M Enabler IIIG can be powered ON by using the PWR_ CTL signal. When using PWR_CTL, the I/O or serial lines can be at any voltage state desired. We recommend that the I/O and serial lines be tri-stated or set low when the GSM0308/GSM0306 is shutdown for an extended period of time to prevent any leakage current from the processor to the modem.
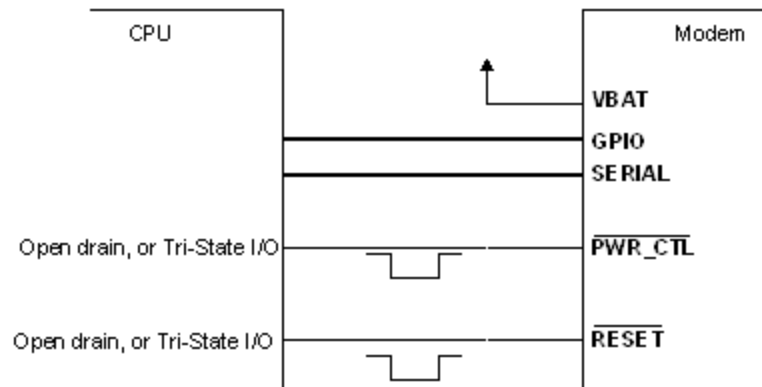
Figure 3-10 Power Control Signal (using external processor)

Parameter	Parameter/Conditions	Min	Typ	Max	Unit
VIL	Input Voltage – Low or float			0.3 x VBAT	Vdc

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Parameter	Parameter/Conditions	Min	Typ	Max	Unit
VIH	Input Voltage – High	0.7 x VBAT		1.95	Vdc
IPU	Internal Pull-Up Resistor	-40	-31	-15	ΘA
IIL	Current sink			-2.0	mA
ON Pulse Duration		10	50		mS
OFF Pulse Duration	Minimum is programmable (AT$OFFDLY)	10	100	5000	mS
Boot time	Time to boot from power on to command prompt		1.1		Sec

Modem Power Switch

If the modem does not respond to signals on the PWR_CTL line, a power cycle (OFF-ON) of the modem's power is required. This condition may occur due to unpredictable network traffic and/or unstable power sources and is more likely when the modem is running 24 hours a day, 7 days a week.

If the host assembly does not control power to the modem, you should add a power switch to the host assembly similar to the one shown below.

Key Features:
+ Low voltage drop (RDSON);
+ Level Shifting to minimize parts count;
+ Current & temperature protection;
+ Soft start to minimize peak start-up current.
+ Load discharge circuit to provide quick shutdown;
+ Ultra low quiescent current;

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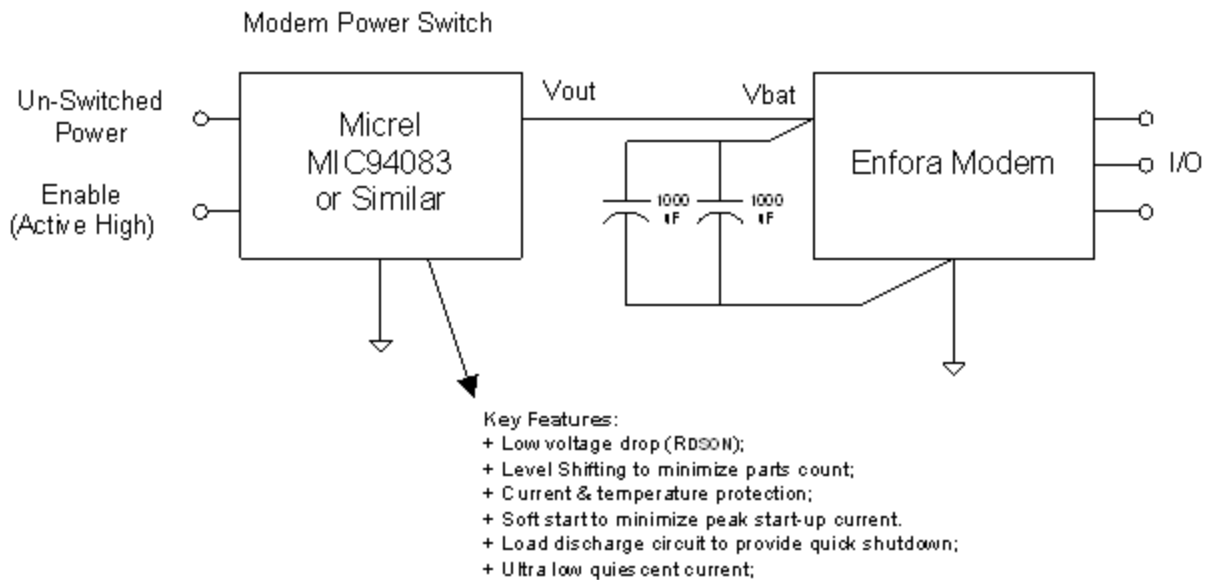
If the modem's I/O lines have another source of power, the modem may not completely shutdown/reset even with a mechanical power switch or with this circuit implemented.

To alleviate this situation, make sure that the interface circuitry is set to tri-state or as an input. If this is not possible, you may need additional hardware to shunt high-impedance lines to ground during these situations.

The un-switched power source must be capable of supporting the inrush current required by the bulk capacitance. The enable switch can be soft-started via voltage ramp or modulation to reduce the peak current.

DO NOT USE a Modem Power Switch as a routine shutdown or reset. This technique for shutting down the modem does not properly deregister the modem from the network. The carrier may impose penalties if a fleet of equipment does not follow a proper deregistration process.

Level Translation Reference Power (Pin 77)

Use pin 77 as a voltage reference source ONLY. Do not connect current loads to this pin. This pin must be decoupled to ground with at least a 0.1 ?F capacitor at the output. Noise induced on this pin will affect the performance of the baseband.

Low-Power Mode is entered when RTCWAKE is used to power down the modem with just the RTC running.

VR I/O	Parameter/Conditions	Min	Typ	Max	Units
Output voltage VOUT	ON mode				
LOW POWER mode	1.65				
1.65	1.8				
1.8	1.95				
1.95	Vdc				
Rated output current IOUT	ON mode				
LOW POWER mode			20		
0.5	mA				

USB (Pins 1, 3, 5, 7, 9)

Pin Name	Pin Number	Signal Direction	Description
USB_VBUS	1, 3	In	5 V tolerant power Supply VBUS line;
Used only as a USB sense, not for powering the module. (optional connection)			
USB_DP	5	Analog I/O	5 V tolerant data plus pin in USB
USB_DM	7	Analog I/O	5 V tolerant data minus pin in USB
ID_USB	9	Analog I/O	5 V tolerant ID line, it defines the type of device connected to the phone's USB port;
And also the default state (host / device) at the cable connection;			
The transceiver senses the voltage of this pin to determine if the pin is either floating (typical),grounded or resistively connected to ground (102 kΩ, 200 kΩ, 440 kΩ);			

This is for Novatel Wireless M2M Debug only

5V Tolerant Transceiver

USB	Parameter/Conditions	Min	Typ	Max	Units
Input Voltage		4.4	4.65	5.25	V
Output voltage	High (Driven)	2.8	3.3	3.6	Vdc
	Low	0.0	0.1	0.3	Vdc
Transceiver D+/- Leakage Current		-2		2	µA

General Purpose Input/Output Interface

GPIO number	Pin number	Secondary Function
GPIO 1	64	
GPIO 2	62	
GPIO 3	60	
GPIO 4	58	
GPIO 5	68	
GPIO 6	70	
GPIO 7	66	
GPIO 8	72	
GPIO 9	14	MCSI_CLK
GPIO 10	16	MCSI_FSYNC
GPIO 11	18	MCSI_TX

GPIO number	Pin number	Secondary Function
GPIO 12	12	MCSI_RX
GPIO 13	30	
GPIO 14	26	
GPIO 15	22	
GPIO 16	24	
GPIO 17	28	
GPIO 18	20	
GPIO 19	34	
GPIO 20	32	

Each general-purpose signal may be selected as an input or an output. The GPIOs can be used independently as a user-specified function, or may be used to provide modem control and status signals. Several examples of modem control signals are: power shutdown command, register/deregister on network command, and transmitter disable. Several examples of modem status signals are: registration status and ready-for-power-down status to be used with power shutdown command signal.

I/O Lines	Parameter/Conditions	Min	Typ	Max	Units
VIL	Input Voltage – Low	0		0.60	Vdc
VIH	Input Voltage – High	1.11		1.8	Vdc
VOL	Output Voltage – Low			0.45	Vdc
VOH	Output Voltage – High	1.26			Vdc
IOL / IOH	Rated Output Current			4	mA

The below table shows the factory default modem GPIO configuration:

I/O No	PU/PD Enabled	PU/DN	I/O set-ting	PU/PD cap-ability	PU Value KOhm	PD Value KOhm	Iout	Notes
1	1	PU	IN	PU/PD	18	90	4	
2	X	X	IN		-	-	8	10k Pulldown on Modem
3	1	PD	IN	PD	-	18	8	
4	1	PU	IN	PU/PD	18	90	4	
5	1	PU	IN	PU/PD	18	90	8	
6	1	PU	IN	PU/PD	18	90	4	
7	1	PU	IN	PU/PD	18	90	4	
8	1	PU	IN	PU/PD	18	90	8	

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9	1	PU	IN	PU	18	-	8	
10	1	PU	IN	PU	18	-	8	
11	1	PU	IN	PU	18	-	8	
12	1	PU	IN	PU	18	-	8	
13	1	PD	IN	PD	-	18	8	
14	1	PD	IN	PD	-	18	8	
15	1	PD	IN	PD	-	18	8	
16	1	PU	IN	PU/PD	90	90	8	
17	1	PU	IN	PU/PD	90	90	8	
18	1	PU	IN	PU	18	-	8	
19	1	PU	IN	PU/PD	18	90	8	
20	1	PU	IN	PU/PD	90	90	8	

Factory Default Settings for I/O Pins, PU/PD Capability and Value of PU/PD Resistors.

RTC Sleep

In this mode, the modem is off except for its Real-Time-Clock. When put into this mode, the modem can wake itself up at a designated time/interval. See Section 4.10 of the Enabler III AT command manual for details

Serial Interfaces & Handshake (Pins 11, 13, 15, 17, 19, 21, 23, 25)

The pin naming for TX/RX/RTS/CTS/DTR/DSR is referenced as a DTE .The DTE device should match their input pins to the Novatel Wireless M2M outputs and vice-versa. Additionally, there are AT commands that may need to be executed in order to insure proper operation. See the chart below.

9 way D Connector Pin Number	Signal	Signal Direction	Novatel Wireless M2M Pin Number	Novatel Wireless M2M AT Command
1	Carrier Detect (CD)	from DCE	19	AT&C
2	Receive Data (RD)	from DCE	15	
3	Transmit Data (TD)	from DTE	21	
4	Data Terminal Ready (DTR)	from DTE	17	AT&D
5	Signal Ground	both		
6	Data Set Ready (DSR)	from DCE	25	
7	Request To Send (RTS)	from DTE	11	AT+IFC
8	Clear To Send (CTS)	from DCE	13	AT+IFC
9	Ring Indicator (RI)	from DCE	23	

PU/PD					

Cap	Used As	Iout		
(mA)	PU			
(Kohm)	PD			
(Kohm)				
PU	DCD output	4	18	-
PD	External RING indicator	8	-	18

Factory Set Pin Configuration

The key features of the UART in the modem mode are as follows:

- 16C750 compatibility
- Baud rate from 300 bits/s up to 115200 Kbits/s, autobaud
- Configurable data format:
    - Data bit: 5, 6, 7, or 8 bits
    - Parity bit: even, odd, none
    - Stop bit: 1, 1.5, 2 bit(s)
- Hardware flow control RTS/CTS
- Software flow control using XON/XOFF characters

The Enabler IIIG module is designed to be used like a DTE device.

Default settings are 8 data, 1 stop, no parity, and auto-baud. DTR may be used to force the modem into AT command mode from online data mode (See AT Command Document, command AT&D). RTS and CTS may be used for hardware handshaking. DSR is always active (connected to ground) while the modem is on. RING may be used to alert the host to a variety of incoming calls.

The serial interface is 1.8V logic. By default, hardware handshaking (AT+IFC) is enabled. The module will be expecting the RTS line to be low before it will transmit data. If the integrator does not wish to use flow control, please see below for minimal serial implementations:.

For a minimal Serial implementation use one of the following two configurations:

Configuration 1:
- Connect RxData (pin 15) and TxData (pin 21) to the COM port serial data lines.
- DTR (pin 17) and RTS (pin 11) be pulled up through a 100K resistor if not used.
- The user must set AT+IFC=0,0 to disable flow control to communicate with the modem.

Configuration 2:

- Connect RxData (pin 15) and TxData (pin 21) to the COM port serial data lines.
- Tie RTS (pin 11) to CTS (pin 13), and DTR (pin 17) to DSR (pin 25) on the modem to loopback the flow control signals
- The user must set AT+IFC=0,0 to disable flow control to communicate with the modem.

Note:
It is not recommended tying DTR (pin 17) and RTS (pin 11) to ground to "spoof" flow control. This will cause the modem to draw more current.
It is not recommended to leave that DTR (pin 17) and RTS (pin 11) unconnected.
If DTR (B12) is not connected, the default setting of AT&D0 must be maintained.

Ring Indicate (Pin 23)

The Enabler IIIG module is capable of using the Ring line to discern the type of incoming call. The indicator can be monitored via a hardware line available on the 100-pin I/O signal connector.

The function of the Ring line depends on the type of the call received.

When the module is receiving a voice call, the Ring line goes low for 1 second and high for another 2 seconds. Every 3 seconds the ring string is generated and sent over the Receive (Data Out) (Rx) line. If there is a call in progress and call waiting is activated for a connected handset or hands free device, the Ring pin switches to ground in order to generate acoustic signals that indicate the waiting call.
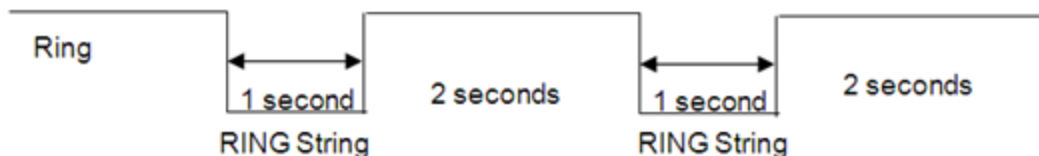
When a Fax or data call is received, Ring goes low and will remain low. Every 3 seconds a ring string is generated and sent over the Receive (Data Out) (Rx) line.

When an incoming SMS is received, Ring indicate goes low for 1 second, then returns to a high state. See below logic diagram.
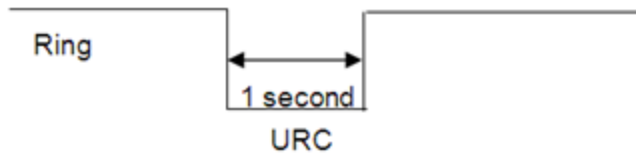
Serial I/O & Control	Parameter/Conditions	Min	Typ	Max	Units
VIL	Input Voltage – Low			0.54	Vdc
VIH	Input Voltage – High	1.26		1.95	Vdc
VOL	Output Voltage – Low			0.54	Vdc
VOH	Output Voltage – High	1.26		1.95	Vdc
IOL / IOH	Rated Output Current			2.0	mA

Multi-Channel Serial Interface (MCSI) – (Pins 12, 14, 16, 18)

This port is only available in Master mode and to be used for PCM digital audio. Below are the settings for configuring it operation and the interface specification:

Digital Audio Configuration

The default settings for the digital audio are:

- Mode = Master
- MCSI_CLK = 520KHz
- Word Size = 16 Bits
- Sync Pulse = 8KHz
- Frame mode = burst
- Clock edge Sync = rising edge

Configuring the MCSI for Digital Audio

The following two commands are required to set the unit up in digital audio mode:

AT$voicepth=2

This configures the EIII module to use digital audio instead of analog audio.

at$ioblks=0,1

This configures the I/O pins of the module to be used as the secondary function which is the MCSI port. It automatically configures the direction of the pins.

Do not alter the settings for these 4 pins manually (direction, pull up or alternate configuration) as this will stop the MCSI port working for digital audio.

Data Format

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The 16 bit word is sent MSB first. Data received is also MSB first. No other data manipulation is done within the module.

Pin Name	Pin Number	Signal Direction	Description
MCSI_RX	12	I	Serial Data Input
MCSI_TX	18	O	Serial Data Output
MCSI_CLK	14	IO	Serial Clock I/O
MCSI_FSYNC	16	IO	Frame Synchronization I/O

VBackup Input (Pin83)

The backup battery can be recharged from the main battery. A programmable voltage regulator powered by the main battery allows recharging the backup battery. The backup battery charge starts when the following conditions are met:

Backup battery charge is enabled by a control bit:
- Main Battery voltage > Backup Battery voltage
- Main battery > 2.8 Vdc

Note: If the backup battery is not present, the backup battery pin is connected to main battery pin

VBACKUP is a power input for the Real-Time-Clock when using RTC-Sleep Function

VBACKUP	Parameter/Conditions	Min	Typ	Max	Units
Input Voltage Range	ON mode	2.5	VCC1	5.5	Vdc
	BACKUP mode, VBAT=0v	1.9	VBACKUP	5.5	
	BACKUP mode, VBACKUP=0v	1.9	VCC2	3.0	
Input Current				10	ꭒA

Using VBackup

VBACKUP is a backup voltage that can maintain the RTC clock and alarm functions. If VBACKUP is not present in the system (intentionally or not) the RTC clock may still be powered if leakage voltage exists on VCC. Otherwise, the RTC clock will lose power and be reset when VCC is restored.

PARAMETER	Parameter/Conditions	Min	Typ	Max	Units

Backup Voltage (Real-Time-Clock)					
VBACKUP	Backup Voltage for Real-Time-Clock	2.7	3.0	4.5	Vdc
IBACKUP	Input Current (VBACKUP = 3.2 V, VBAT = 0 V, No Load on GPIO or Serial Port)		3.0	6.0	⏀Adc

VBACKUP had been tested in the above scenarios and does not contribute to leakage. It will properly provide backup power to the RTC clock.

KHZ Output (Pin 56)

A 32.768 kHz signal is available as an output from the module. This signal should only be used as an input to a high impedance device. Additional loads or capacitance on the line may cause performance issues with the module. If the line is not used, leave floating.

32kHz Clock-Out	Parameter/Conditions	Min	Typ	Max	Units
VIH					Vdc
VIL					Vdc
Maximum capacitor load				tbd	pF
Maximum resistive load					⏀
Frequency	⏀30 ppm		32.768		kHz

Analog-to-Digital Input (Pin 74)

The monitoring ADC (MADC) consists of a successive approximation 10–bit analog–to–digital converter (ADC).

Analog-To-Digital Input	Parameter/Conditions	Min	Typ	Max	Units
ADCBRES	ADC Binary Resolution			10	Bits
ADCREF	ADC Reference Voltage		1.75		Vdc
VADC	ADC Range	0		1.75	Vdc
Integral/Differential Non-Linearity		-2		2	LSB
Input Leakage			tbd		⏀A
Retuning Frequency			1		MHz

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Handset Microphone Input (Pins 65, 67)

The handset differential inputs MICIP and MICIN can be amplified by the differential handset microphone amplifier. This amplifier has a gain of 25.6 dB and a bias generator MICBIAS provides an external voltage of 2 V or 2.5 V to bias the microphone.

Handset Mic Input	Parameter/Conditions	Min	Typ	Max	Units
Maximum Input Range –					
Mic(+) to Mic(-)	Inputs 3 dBm0 (Max. digital sample amplitude when PGA gain set to 0 dB)			32.5	mVRMS
Nominal Ref. Level –					
Mic(+) to Mic(-)	Differential MIC				
		-10		dBm0	
Differential Input Resistance –					
Mic(+) to Mic(-)	Differential MIC, MICAMP gain = 25.6 dB				
(INMODE = 0001)					
		36		kΩ	
Microphone Pre-Amplifier Gain	Differential MIC				
		25.6		dB	

Handset Microphone Bias Output (Pin 63)

Mic Bias Output	Parameter/Conditions	Min	Typ	Max	Units
Bias Voltage on Mic(+)	Set to 2.0 V	1.9		2.1	Vdc
	Set to 2.5 V	2.4		2.6	Vdc
Mic Bias Current Capability				2.0	mA

Handset Speaker Output (Pins 71, 73)

Pin Name	Pin Number	Signal Direction	Description
EARP	71	O	Earphone positive output
EARN	73	O	Earphone negative output

The earphone amplifier provides a full differential signal on the terminals EARP and EARN (Earphone).

Handset Spkr Output	Parameter/Conditions	Min	Typ	Max	Units
Maximum Differential Resistive Load	Output Swing 3.9 VPP		120		Ω
	Output Swing 1.5 VPP		33		Ω

		Min	Typ	Max	Units
Maximum Differential Capacitive Load				100	pF
Common Mode Minimum Resistive Load	At Internal Speaker (+) or (-)	200			kΩ
Common Mode Maximum Capacitive Load	At Internal Speaker (+) or (-)		50		pF
Amplifier Gain	EARG = 1				
EARG = 0		1			
-11		DB			
dB					

Parameter	Test Conditions	Min	Typ	Max	Units
Earphone output swing at EARP-EARN	Distortion ≤ 2% and 120 Ω, VSP input level = +3 dBm0, amp gain = -11 dB		0.98		VP-P
	Distortion ≤ 2% and 33 Ω, VSP input level = -5.34 dBm0, amp gain = -11 dB		0.38		
	Distortion ≤ 2% and 120 Ω, I2S input level = +3 dBm0, amp gain = -11 dB		0.93		
	Distortion ≤ 2% and 120 Ω, VSP input level = +3 dBm0, amp gain = 1 dB	3.1	3.92		
	Distortion ≤ 2% and 33 Ω, VSP input level = -5.34 dBm0, amp gain = 1 dB	1.2	1.5		
	Distortion ≤ 2% and 120 Ω, I2S input level = +3 dBm0, amp gain = 1 dB	2.96	3.7		
Earphone amplifier gain	EARG = 1		1		dB
	EARG = 0		-11		dB
Earphone amplifier state in power down			High Z		
Earphone amplifier power supply rejection	1 kHz, 100 mVp-p		50		dB

An external audio amplifier should be used for loads of less than 16 Ω or if volume is inadequate.

Headset Microphone Input (Pin 55)

Mic Input	Parameter/Conditions	Min	Typ	Max	Units
The headset differential inputs HSMIC and AUXI can be amplified by the differential handset microphone amplifier. This amplifier has two different gains 4.9 dB or 25.6 dB and a bias generator HSMICBIAS provides an external voltage of 2 V or 2.5 V to bias the microphone. Headset Mic Input					
Maximum Input Range	Inputs 3 dBm0 (Maximum digital sample amplitude with PGA gain set to 0 dB), AUXAMP gain = 18 dB, Single HSMIC			78	mVRMS
Nominal Ref. Level			-10		dBm0

				18	dB
Microphone Pre-Amplifier Gain					
Input resistance at HSMIC					
	HSMIC single input, AUXAMP				
gain = 18 dB					
		40.5		kΩ	

Headset Microphone Bias Output (Pin 53)

Mic Bias Output	Parameter/Conditions	Min	Typ	Max	Units
Bias Voltage on Mic(+)	Set to 2.0 V	1.9		2.1	Vdc
	Set to 2.5 V	2.4		2.6	Vdc
Mic Bias Current Capability				2.0	mA

Headset Speaker Output Left & Right (Pins 57, 59)

Pin Name	Pin Number	Signal Direction	Description
HSOL	57	O	Headset Out 32✦Speaker Left
HSOR	59	O	Headset Out 32✦Speaker Right
HSOVMID	61	I	Headset Out pseudo ground return

The left and right headset amplifiers provide the stereo signal on terminals HSOL and HSOR. A pseudo ground is provided on terminal HSOVMID to eliminate external capacitors. The mono audio signal can be provided on the Right or the Right and Left headset outputs. HSOVMID is available to allow integrators to supply a bias or DC offset to increase the dynamic range of the Headset.

Headset Spkr Output	Parameter/Conditions	Min	Typ	Max	Units
Maximum Swing	Distortion ⭘2% and 32 ✦, VSP input level = +3 dBm0	1.6	1.96		VP-P
	Distortion ⭘2% and 32 ✦, I2S input level = +3 dBm0	1.48	1.85		
Maximum Capacitive Load				100	pF
Minimum resistive load at HSOL and HSOR: Zload					
			32		✦
Amplifier Gain			-5		dB
HSOL/R amplifier Power supply rejection					
	1 kHz, 100 mVpp				

		50		dB	
Amplifier State in Power Down			High Z		

The left and right channels of the headset speaker output are a single ended output. An external audio amplifier should be used for loads of less than 32 Ω or if volume is inadequate.

Headset Output Common Mode (Pin 61)

The left and right headset amplifiers provide the stereo signal on terminals HSOL and HSOR. A pseudo ground is provided on terminal HSOVMID to eliminate external capacitors.

HSOVMID	Parameter/Conditions	Min	Typ	Max	Units
Maximum Capacitor Load				200	pF
DC Level		1.2	1.35	1.5	V

Headset Detect (Pin 47)

Headset Plug/Unplug detection. This pin is used to automatically switch to the headset audio path when enabled with AT$VSELECT=3. The device will default to handset when no Headset is detected.

2 modes:

- Module already ON (Battery connected, VRIO ON) and plug event;
- Module OFF and plug event: the plug detection will be effective once VRIO is set ON

Plug and unplug detections are digitally debounced (debouncing time = 8 ms).

The jack plug detection feature is addressed through the HSDET pin. The integrated pull up, connected to the pin, forces a high level (VBAT) when the headset load is not connected. At jack insertion headset load connection (32 Ω) imposes a low level on that node (Headset left channel): as an example HSDET = 1 mV after jack plug for VBAT = 4 V.

Input comparator threshold voltages are defined as VTlow = VBAT/2 – 100 mV and VThigh = VBAT/2 + 100 mV, VBATmin = 3.2 V. The plug and unplug detection remains functional if there is no signal from HSOL amplifier output (stereo path is OFF) or if there is a signal from HSOL (stereo path is ON): maximum level on HSOL when the stereo path is ON is 1 Vp-p which stays far enough from the comparator threshold levels VBATmin/2 – 100 mV and VBATmin/2 + 100 mV.

Jack plug detection is functional if a plug event occurs before the power up of the module or if the plug event occurs after the power up of the module: analog detection part is always active if the battery is connected. Detection interrupts will be generated once the VRIO regulator is power up during the module power up sequence.

A level change on HSDET pin is sensed by a Schmitt trigger to provide a jack detection signal to the audio digital control. The audio digital control receives the detection signal and proceeds to a digital debouncing (time: 8 ms = 256 * 32 kHz clock periods) before sensing that a plug event happened on the jack connector.

Headset Detect	Parameter/Conditions	MIN	TYP	MAX	UNIT
Low level input voltage VIL related to VBAT					
				0.3 * VBAT	V
High level input voltage VIH related to VBAT					
		0.7 * VBAT			V
Current with pull-up		-40	-31	-15	µA

Subscriber Identity Module (SIM) Carrier (Pins 76, 78, 80, 82, 84)

The SIM, an integral part of any GSM terminal device, is a "smart card" that is programmed with subscriber information:

- The user information consists of an International Mobile Subscriber Identity (IMSI) number, which is registered with the GSM provider, and an encryption Ki (pronounced "key"). This information consists of a microprocessor and memory installed on a plastic card.

Note: The SIM is not provided with the Novatel Wireless M2M Enabler IIIG module. The SIM must be obtained from the GSM service provider and must be provisioned by the operator for data and/or voice. Always take care to protect the SIM: the GSM terminal will not operate without the SIM installed.

The SIM provides the IMSI for authentication. To gain access to the GSM network, the network must recognize the IMSI number, and the terminal must be able to properly decrypt the data sent by the network. The SIM also serves as a buffer for SMS messages, storing the message for transmission until a radio link is available and buffering received messages until retrieved.

SIM INTEGRATION FOR THE Novatel Wireless M2M ENABLER IIIG MODULE

The Enabler IIIG module default configuration does not include an on-board SIM carrier. Novatel Wireless M2M provides a separate product SKU for the Enabler IIIG module with the integrated SIM carrier.

Using A Remote SIM With The Novatel Wireless M2M Enabler IIIG Module (PINS 76, 78, 80, 82, 84)

The Enabler IIIG module default configuration does not include an on-board SIM carrier.

The module supports the use of 1.8 V and 3 V SIM cards. The module includes a hardware interface module dedicated to Universal Subscriber Identity Module (USIM). All baud-rates defined in ISO 7816-3 standard are supported for high-speed transmission.

The module optionally includes an on-board SIM carrier. All other modules require a remote SIM carrier/connector. If the module is going to be integrated using a remote SIM, the following guidelines are provided:

- To utilize a remote SIM, the integrator must provide a suitable SIM connector.
- The maximum distance from the module to the remote SIM connector must not exceed 25.4 cm (10 inches).
- It is recommended to have Zero resistance between the SIM connector and the module.
- External ESD Protection is Required;
    - 15 kV Air Discharge;
    - 8 kV Contact Discharge;

The transorb must have a low junction capacitance (typically < 10 pf) such as the following part:

Novatel Wireless M2M PN: TRS-0000-5009

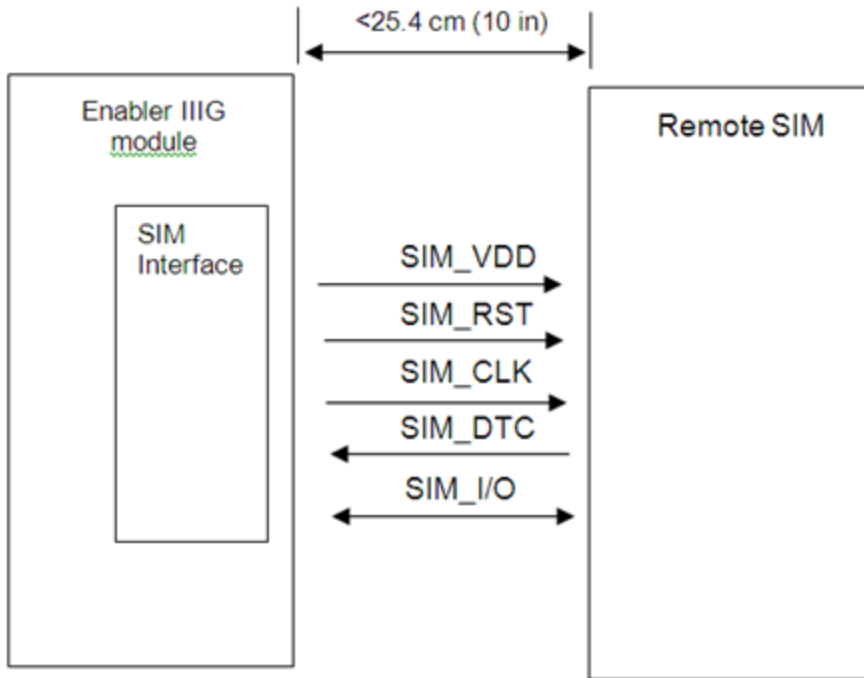Manufacturer: On Semi

Manufacturer PN: NSQA6V8AW5T2G

Figure 3-11 Remote SIM Interface

Pin Name	Pin Number	Signal Direction	Description
SIM_VDD	76	O	SIM VDD
SIM_CLK	78	O	Card Reference Clock
SIM_RST	80	O	Card Reset
SIM_I/O	82	I/O	Card I/O Data
SIMDTC	84	I	Card detect

The module provides the regulated supply voltage for the SIM-card and the circuitry to detect the insertion or extraction of the SIM-Card in or from the mobile.

The SIMDTC is disabled by default (see AT$SIMDTC in the EIII AT Command Manual for settings). When enabled, the SIMDTC pin has an internal pull up to Vcc and can be configured to detect a SIM insertion when the SIMDTC is either pulled to ground or left floating.

It can configured to detect either just a SIM removal or both removal and insertion. SIM detection is also dependent on the setting of the AT$AREG and AT+CFUN commands (see AT$SIMDTC in the EIII AT Command Manual for more information).

When the module detects a SIM removal, it will de-register from the network. When the module is configured to and detects a SIM insertion, it will re-register the module on the network.

The SIM-card presence detection logic is active even when the system is in idle mode.

USIM	Parameter/Conditions	Min	Typ	Max	Units
VDD	SIM VDD voltage	1.65	1.8	1.95	V
		2.7	2.85	2.95	V
VIH	High level input voltage	1.15			V
VIL	Low level input voltage			0.61	V
VOH	High level output voltage, IO = 4 mA	Vdd-0.45			V
VOL	Low level output voltage, IO = 1 mA			0.4	V
II	Input leakage current			±1	µA
Iout	Output current		4		mA
PU	PU resistance		32		kΩ
PD	PD resistance		30		kΩ
Iz	Leakage current			± 30	µA
Card Detect	Debouncing time (SIM-card insertion)		0.5		mS
	Debouncing time (SIM-card extraction)		15		mS
	Pull-up resistor (resistor + resistive switch)		475		kΩ

Remote SIM Component Information

Any compatible SIM carrier can be used in conjunction with the Enabler IIIG module. For example:

Lumberg P/N 8840_A_21.

or Suyin P/N: 254016MA006G103ZL

Remote SIM Example

ESD protection is required for all SIM sockets. A Transient Voltage Suppressor (TVS) diode with low capacitance, typically less than 10pF, should be used. ESD protection is required for PTCRB and GCF approval and should be located as close to the connector as possible. Signal lines from the connector to the modem should be routed 'through' the pad of the diode, rather than a 'T' branch. Decoupling capacitance on SIM_VDD will be required, and should be placed as close to the SIM connector as possible. The value of the required capacitor will vary by design, and will typically be below 0.1uF. The SIM electrical tests will be conducted during the PTCRB and GCF approval process. Experimentation of the capacitance value may be required to pass these tests. Factors affecting the capacitance of the SIM_VDD line include: trace length, capacitance of the TVS diode, and physical placement of the capacitor.
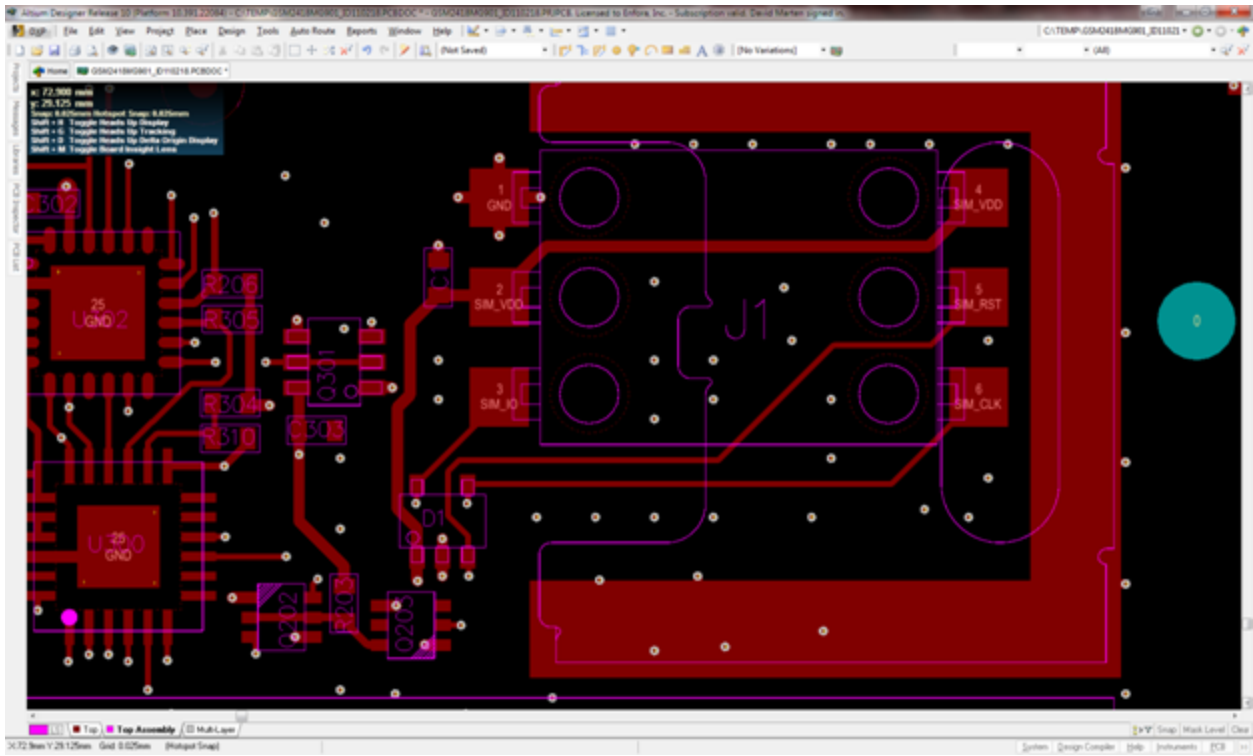
Figure 3-12 Remote SIM Example

4

Hardware Design

General Design Guidelines For Using Novatel Wireless M2M GSM Modules

The following guidelines are provided in an effort to allow Enabler IIIG module users to successfully implement their PCB layout to obtain the best performance. This includes the lowest possible EMI emissions, maximum thermal conduction, mechanical integrity, and voice quality. The Enabler IIIG module is a very compact, high performance design, yet it is easy to interface into the final product. In order to realize its full potential, designers should pay close attention to ground structures, the routing of RF and Digital traces, and the size of the power supply lines.

> Warning: These design tips are strictly guidelines and are not meant to be a complete list of items that guarantee actual performance. Each application is different and may require variation from these guidelines, however, care should be given to utilize these sound engineering principles whenever possible

Advanced Tips For An RF Friendly Layout

To ensure the lowest possible EMI emissions and maximum thermal conductivity, it is recommended that all metal tabs on the GSM module shield must be soldered down onto a continuous ground plane that runs under the entire module. Ample ground vias should be provided around the metal tabs to create a low impedance ground. It is recommended to minimize the number of I/O and power traces and vias under the GSM module to allow for as much ground plane as possible. An example of a good ground structure and pad layout is shown below in Figure 1.
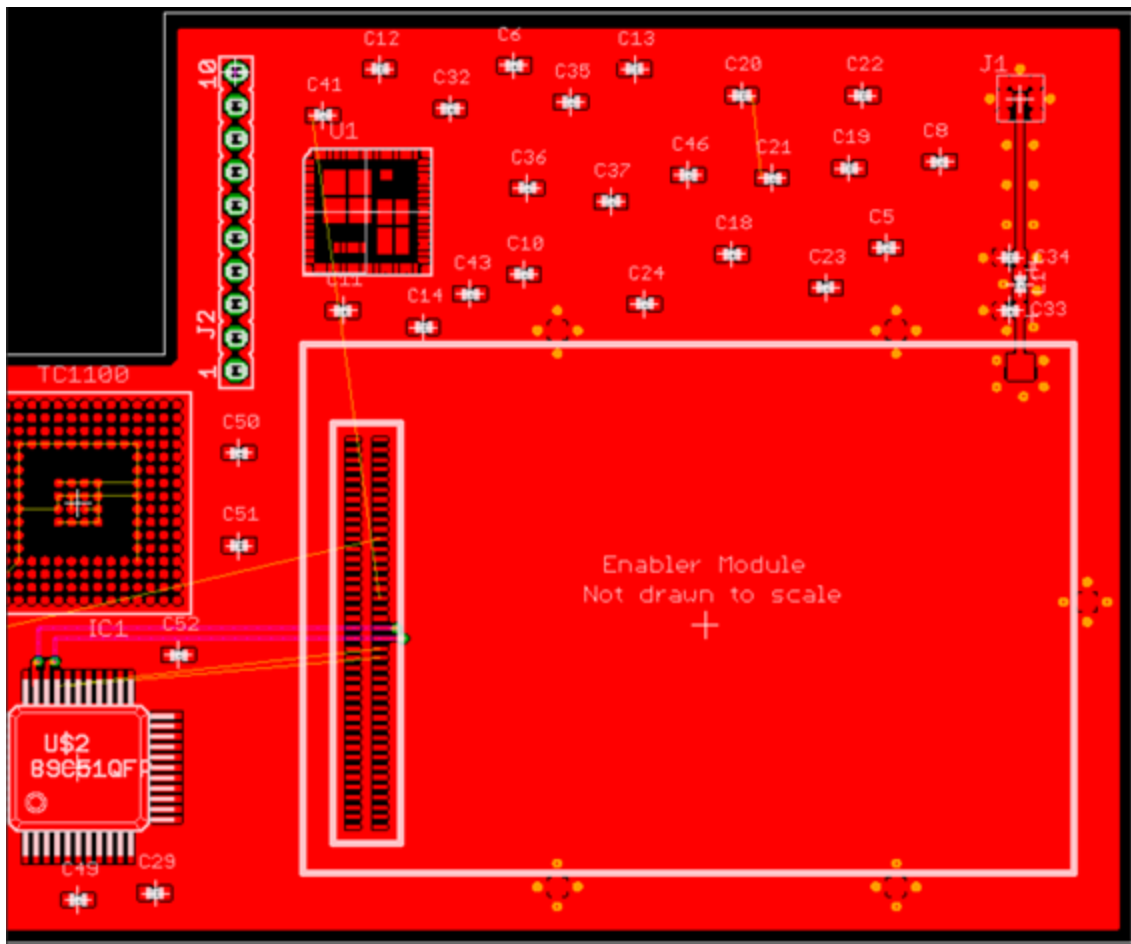
Figure 4-1 Example of good ground plane for GSM modules

Thermal Relief

Because the ground plane acts as a large heat sink, it can affect the solderability of components. A common method to reduce this effect is to use thermal relief around the pad in question. However, great care must be taken when using thermal relief for high current or high frequency applications

For example, a large thermal relief like the one shown in Figure 2 can serve the purpose for general applications such as low current, low speed data lines, DC connections and audio frequency applications. However, such thermal relief structures should be avoided for applications where high current and/or high frequency is involved, such as those using the Enabler Module. Depending on the frequency of operation, the long narrow thermal relief traces between the pad and the ground plane act like an RF choke. These RF chokes become higher impedance at harmonics of the fundamental frequency making it problematic for high frequency suppression. This can make it difficult to pass type approval testing.
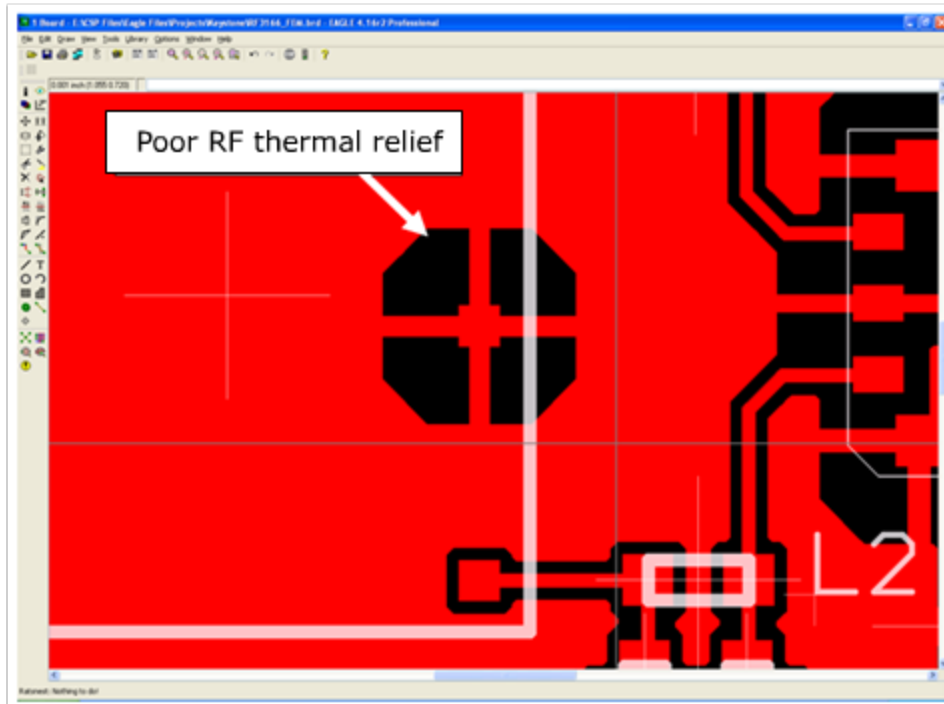
Figure 4-2 Example of a POOR RF Thermal Relief

If thermal relief is necessary, it is recommended that you use short, fat traces similar to those shown in Figure 3. This will still provide a solderable connection, while providing a better RF connection. Making them shorter also allows for a more continuous ground plane due to less copper being removed from the area. It is also recommended to have ground vias around all thermal relief of critical ground pins such as the five Enabler shield tabs.
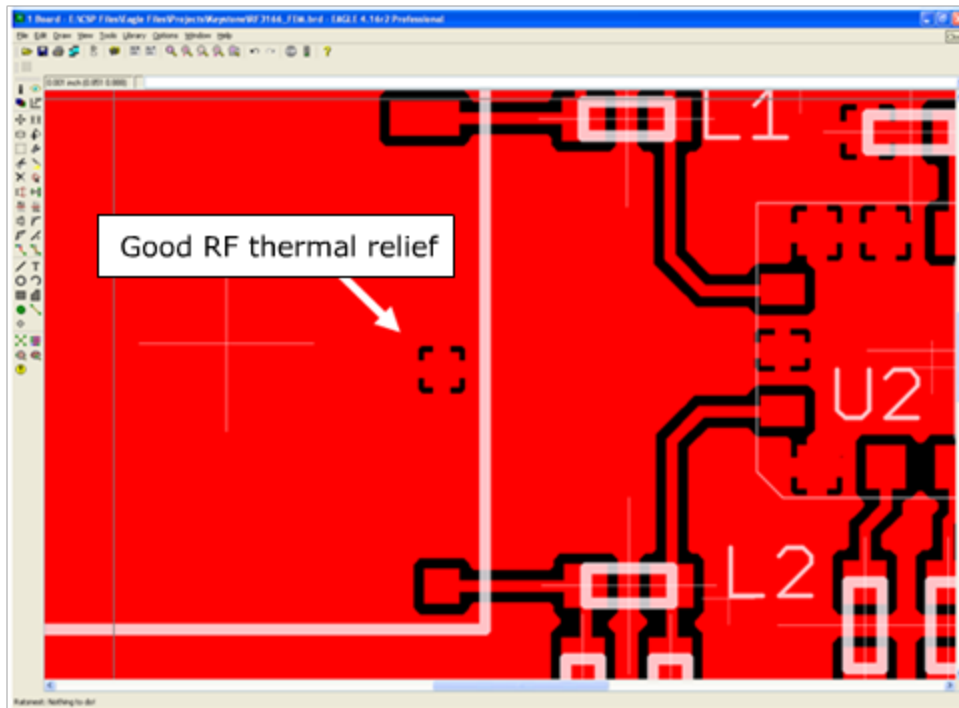
Figure 4-3 Example of a GOOD RF Thermal Relief

Antenna And RF Signal Trace

The PCB trace that feeds the RF output port must be designed for a 50 ohm characteristic impedance, coplanar, or routed into internal layers to keep the top layer continuous around and underneath the Enabler module. Ample ground vias should be provided around the RF contacts, the RF trace and launch pad. If possible, keep I/O and power traces away from the RF port. This includes traces running parallel or orthogonal to it. Thermal relief should not be used on the antenna output port ground pads. The designer must pay close attention to the size of the pad and thickness of the dielectric beneath the signal pad and trace. Most PCB manufacturers can adjust the trace width to maintain 50 ohms impedance if the traces are identified and instructions are included on the FAB drawing. This service is typically provided at no or minimal additional cost.

For minimum RF emissions due to the fundamental frequency of operation, the Enabler module works best with an antenna load that has a VSWR of 1.5:1 or better. The antenna should not have gain at the harmonic frequencies, otherwise, the conducted harmonics could get amplified to a point where the product no longer passes type approval. However, for

applications where antenna quality is less than ideal, it is recommended to have a low pass filter (Pi structure with N=3) in the RF path to the antenna. This is a secondary plan should there be a need to lower harmonic levels at frequencies above the PCS band. The pad structure may also be used to match the antenna load impedance, if required. If it is not needed, a capacitor of low reactance may be used to bridge the Pi structure.

The RF cable going between the Enable module and the antenna is very lossy, therefore, the length of this cable should be kept as short a possible.

VBAT Input

The Enabler Vbat input can have a relative high current draw that can fluctuate rapidly, especially when transmitting at max power and burst mode. The Vbat interface must be designed to provide the required instantaneous voltage and current with minimal voltage droop. This includes both sufficient bulk decoupling capacitance as well as adequate layout provisions.

When laying out the connections to the Enabler interface connector, it is tempting to use traces of the same width as the connector pins. However, this is a very compact connector and traces of that width will not have sufficient copper. Similar to the discussion on thermal relief, the use of narrow traces to connect the Vbat pins to the source voltage can act like a high impedance and cause a significant voltage droop when higher currents are required as shown in Figure 4.
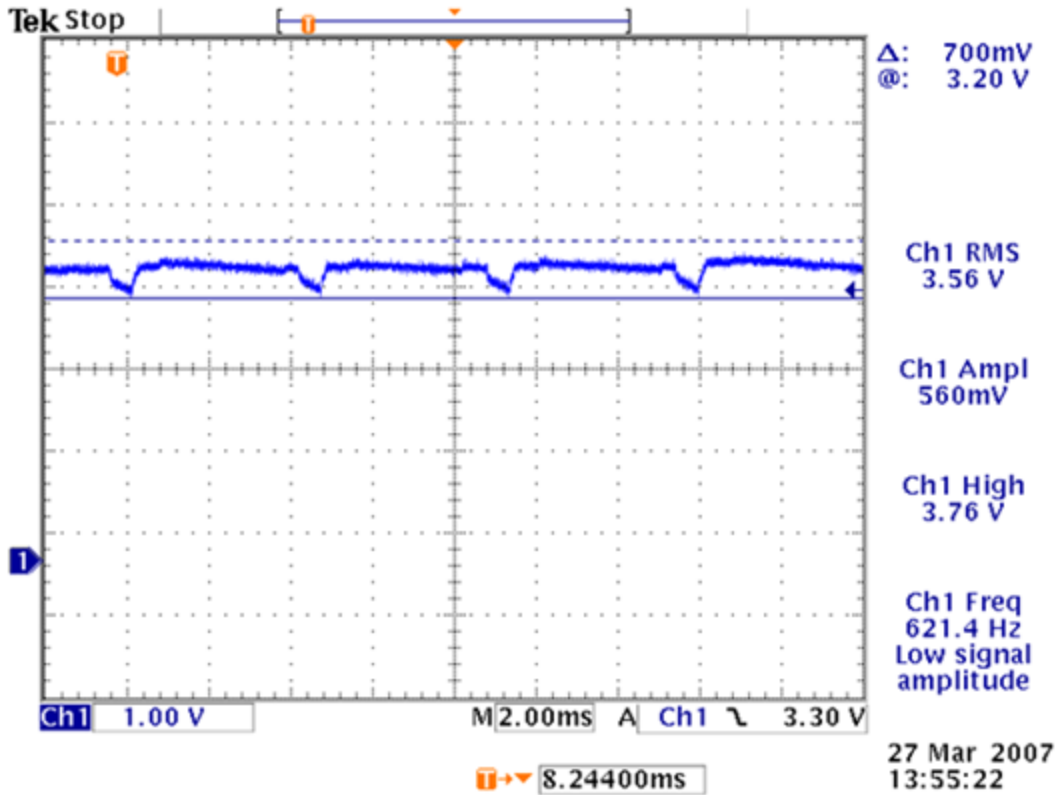
Figure 4-4 Example of Vbat Voltage Droop

If the Vbat drops too low, the Enabler modules will reset. To minimize the trace loss, it is suggested to use a larger trace that spans several pins as shown in Figure 5. Any concern about solderability can be mitigated by using solder mask with cutouts for the individual pins as shown by the blue lines in the figure. The layout should provide sufficient trace width over the entire trace from the Enable modules all the way to the source of the Vbat voltage. Any transitions between layers for this trace should utilize multiple vias.

Since even the best layout will have some impedance from the source to the Enabler module, sufficient bulk decoupling capacitance is required at the Vbat input to the Enabler module. It is suggested to use at least two 1000 uF, low ESR, tantalum capacitors located very close to the Enabler interface connector Vbat pins. Any thermal relief used on these capacitors should comply with the information given above in order to provide the lowest impedance possible. The grounding of these capacitors is critical. Therefore, it should be a low impedance and should utilize multiple vias to the internal ground plane close to the capacitor as well.
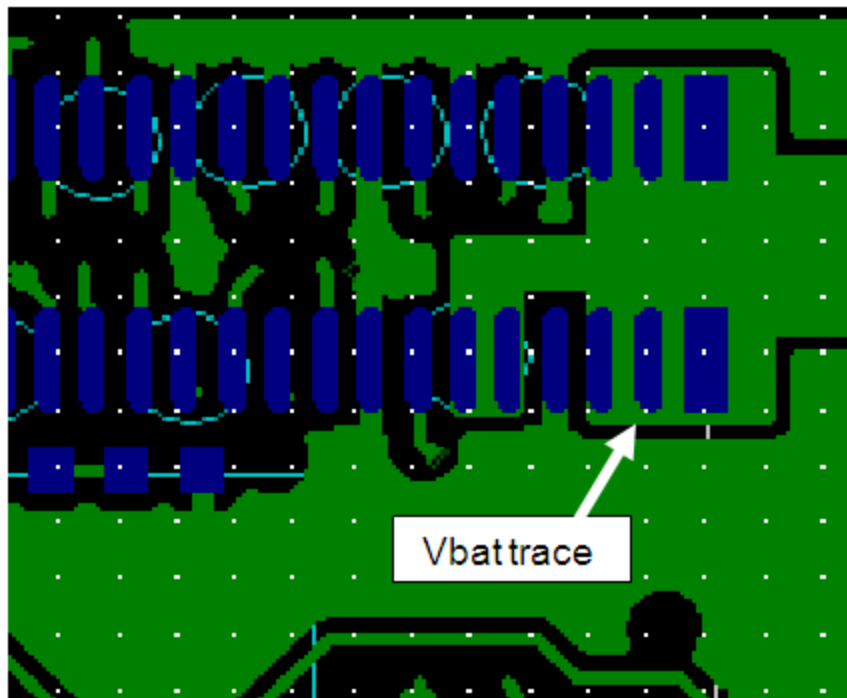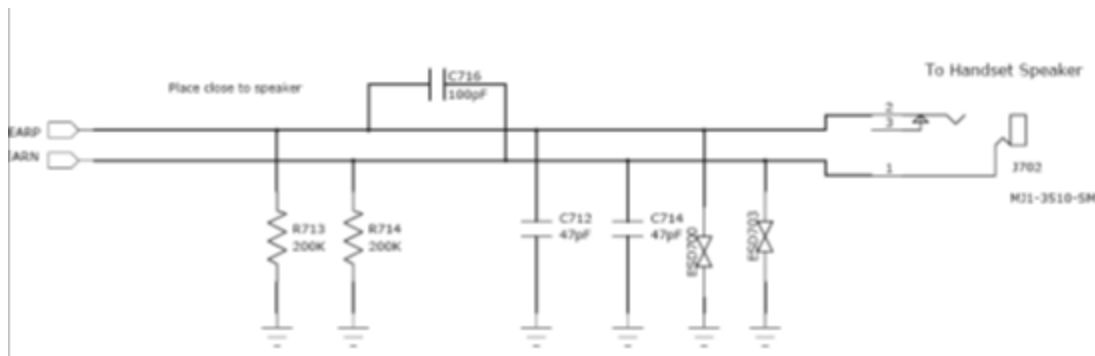
Figure 4-5 Example of GOOD Vbat layout

Audio Reference Design

The audio quality is very dependent on the circuit design and layout. As an aid to obtaining good audio quality, a reference design has been included below. It has been proven to provide good performance on the SDK module.
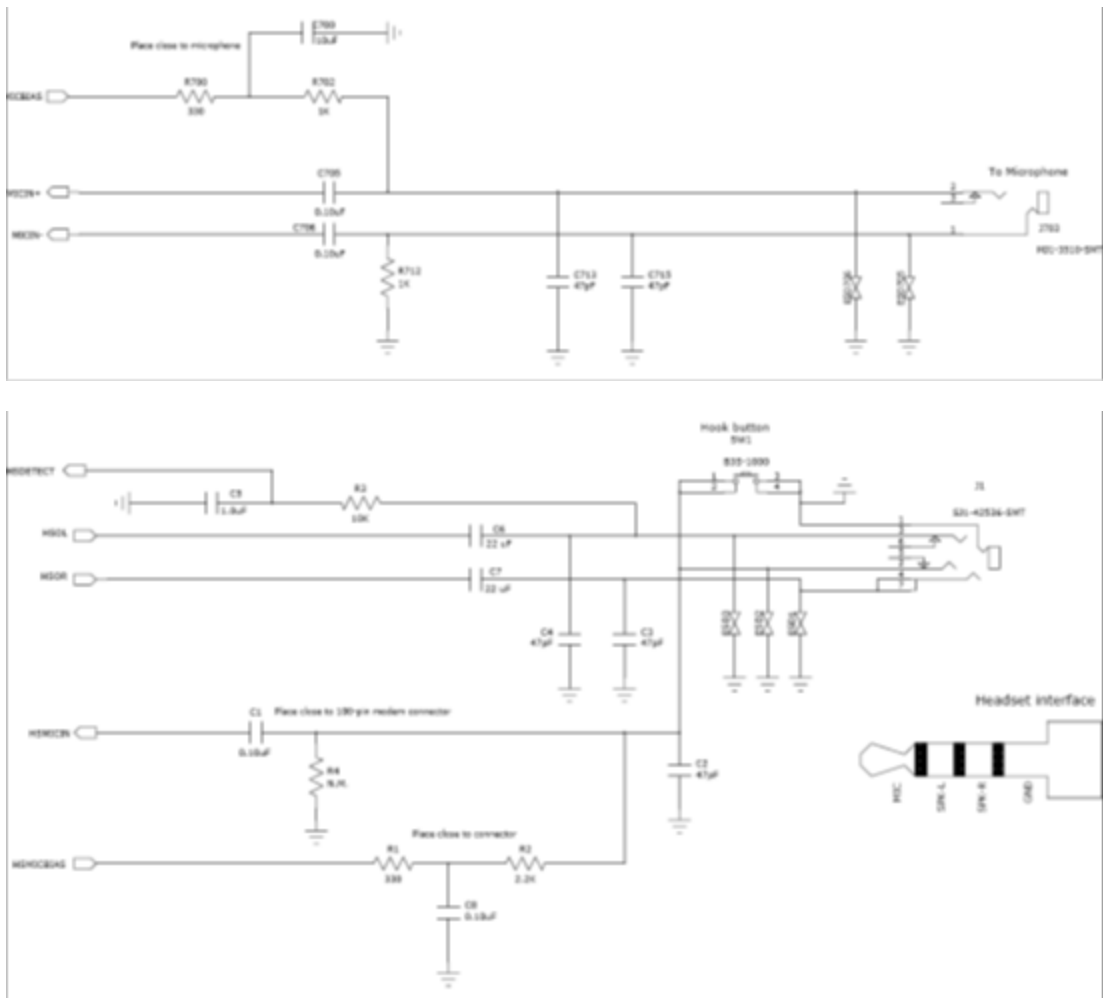
Audio Schematics

Figure 4-6 Audio Reference Design Schematic

GSM/GPRS supports many optional services and modes. The Novatel Wireless M2M Enabler IIIG module supports the following GSM/GPRS services:

- Circuit-switched data
- Short-Message Services (SMS)
- Class B GPRS Functionality
- Voice communication

Enabling The Transmission Modes For The GSM/GPRS Services

Each of the GSM/GPRS services has two modes that can be enabled separately:

Mobile-originated (MO): allows the making of a service request (such as, making a telephone call or sending an SMS)

Mobile-terminated (MT): allows receiving a service request (such as receiving a telephone call or an SMS)

Note: Contact your local GSM operator to ensure that the services and modes have been provisioned for the SIM

Voice Communication

The Novatel Wireless M2M Enabler IIIG module has full voice capabilities, provided the necessary connections have been made for the speaker and microphone pins on the 100-pin I/O connector. The Novatel Wireless M2M Enabler-IIIG AT Command Set Reference - GSM0308AT001 has the entire list of commands that can be used to control the voice functionality. The quick start guide in this manual provides a basic command set that can be used to initialize and test the voice functionality.

The Novatel Wireless M2M Enabler IIIG module supports four vocoder compression algorithms for voice communication: Full-Rate (FR), Enhanced Full-Rate (EFR), Half-rate (HR) and Adaptive Multi-rate (AMR).

Circuit-Switched Data

In this mode, the Novatel Wireless M2M Enabler IIIG module supports both of the connection modes of transmission that are provided by GSM:

Non-Transparent mode delivers a constantly low error rate but with a non-guaranteed throughput or delay. The Non-Transparent service provides a performance that is closest to using a modem over a fixed Public Switched Telephone Network (PSTN) line.

Note: All GSM service providers may not support transparent mode. In those cases, the Novatel Wireless M2M Enabler IIIG module can be configured to switch automatically to Non-Transparent mode. This capability depends on the settings in the AT+CBST command.

SMS: Short Message Services

- Short Message Services (SMS) is a feature-rich GSM service. The Novatel Wireless M2M Enabler IIIG module can perform the following tasks:
- Sending and receiving binary messages of up to 160 characters (7-bit characters)
- Sending and receiving text messages of up to 140 bytes (8-bit data)
- Submitting a SMS Protocol Data Unit (PDU) to a SMSC (Short Message Service Center) and storing a copy of the PDU until either a report arrives from the network or a timer expires
- Receiving a SMS PDU from a SMSC
- Returning a delivery report to the network for a previously received message
- Receiving a report from the network
- Notifying the network when the module has sufficient memory capacity available to receive one or more SMS messages (after the module had previously rejected a message because its memory capacity was exceeded)

Provisioning The SIM

The SIM can support optional features or services. Most operators typically configure the SIM to send/receive voice calls and to receive SMS; however, some may require an additional tariff to enable the SIM to send SMS. The transmission of circuit switched and GPRS data are also additional services that may be required to allow the service:

- Mobile-originated (MO): allows making a service request (such as, making a call or sending an SMS)
- Mobile-terminated (MT): allows receiving a service request (such as, receiving a phone call or an SMS)

It is imperative for the Novatel Wireless M2M Enabler IIIG module that the SIM be configured for the optional services that are required for the application.

GSM Services Supported By The Novatel Wireless M2M Enabler IIIG Module

The Novatel Wireless M2M Enabler IIIG module supports four GSM services (modes of operation) that must be enabled by the operator:

- Voice calls (MO and MT): requires a telephone number
- SMS (MO and MT): uses the telephone number for Voice
- Circuit-switched data calls (MO and MT): requires a telephone number
- The GSM SIM can have multiple telephone numbers.

GPRS Services Supported By The Novatel Wireless M2M Enabler IIIG Module

The Novatel Wireless M2M Enabler IIIG module supports the following GPRS (modes of operation) that must be enabled by the operator:

- GPRS Packet Connectivity (MO and MT) with Both Dynamic and Static IP option
- GPRS SMS (MO and MT): uses the IP (Dynamic or Static) set by the operator
- Multiple APN Setting
- Quality of Service Options
- Multi-slot 10 Class of Service

Selecting The GSM Modes Of Operation

When provisioning the SIM for the Novatel Wireless M2M Enabler IIIG module, enable the following modes of operation:

- Voice calls: configure the SIM for both MO and MT service (to send and receive)
- SMS: configure the SIM either for MT alone (to receive) or for both MO and MT (to send and receive)
- Circuit Switched Data: configure the SIM either for MO alone (to send) or for both MO and MT (to send and receive)

Voice	SMS	CS Data	GPRS Function
MO/MT	MT	MO	Voice calls, receive SMS, make data calls
MO/MT	MO/MT	MO	Voice calls, receive / send SMS, make data calls
MO/MT	MO/MT	MO/MT	Voice calls, receive / send SMS, make / receive data calls

(requires an additional data telephone number)

5

Setup And Initialization

General Setup

The GPRS modem is controlled through the Modem RS232 port on the development board. Connect a 9-pin straight through serial cable from the Modem RS232 connector to the serial port on the controlling computer.

Hook up power supply, connect antenna, and install SIM into modem.

Hyperterminal Configuration For The Enabler IIIG Module

The following provides an example for setting up a Windows HyperTerminal session that can be used to experiment with various configurations on the module for controlling computer:

1. Select the connection interface, Direct to Com 1 (or whatever port is the serial port).

Figure 5-1 Hyper Terminal Definition

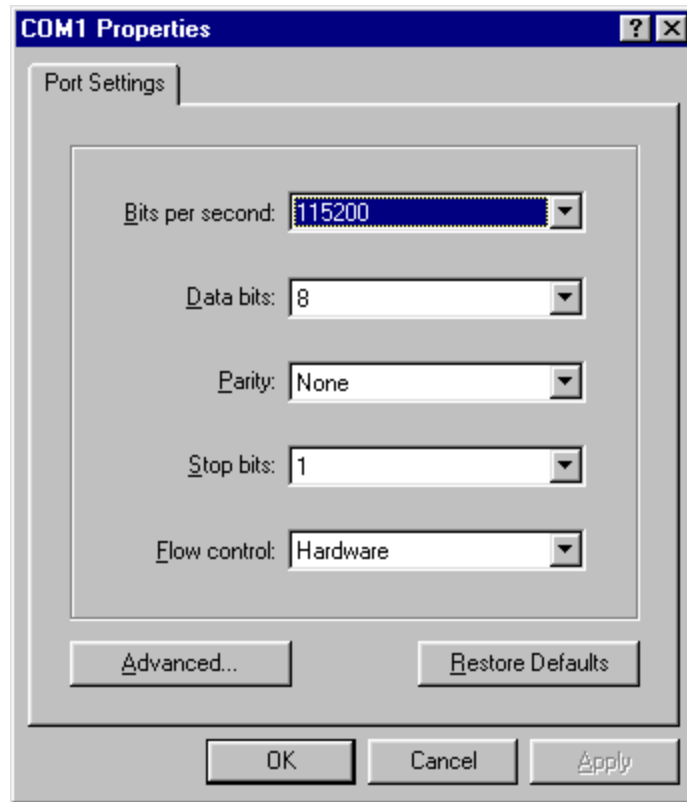2. Configure the COM port as displayed in Figure 21.

Figure 5-2 COM Port Settings

Initialization (AT Command Interface)

In the GSM vocabulary, a call from GSM mobile to the PSTN is called a "mobile-originated call" or "outgoing call". A call from the fixed network to a GSM mobile is called a "mobile-terminated call" or "incoming call."

In the following examples, "Entry" refers to the application. The following convention describes the direction of the data exchange:

- The data exchange from the customer application to the module is designated as: Entry
- The data exchange from the module to the customer application is designated as: Response

Note: With the exception of the +++ command (Online Escape Sequence), all commands must be preceded by the AT attention code (or command prefix) and terminated by pressing the <CR> character.
In the following examples, the <CR> and <CR><LF> are intentionally omitted for clarity and space.

Initial Response To The AT Command

After power is applied to the module, the module performs a power-up self-test. The self-test completes within one (1) second. When queried with the AT command, the module responds with one of the following result codes:

- OK signifies that the module is ready, that it correctly interprets the AT command, and that it has executed the command.
- ERROR signifies that the module does not understand the command or that the command is invalid.

Entry   AT
Response OK Command valid: module is ready

The module must be in AT Command mode when any command is entered (with the exception of the online escape sequence). Commands entered when the module is in On-line mode are treated as data, and are transmitted as such to the receiving module. (i.e. If the module is in PPP or SLIP mode, AT commands cannot be entered.)

Sending An Initialization String To The Enabler IIIG-BGA Module

The following example provides the sample AT commands and responses for the following initialization tasks:

- Reset the module to the factory defaults
- Disable character echo
- Transmit Result Codes
- Set the module to Verbose mode (to display result codes as words)
- Set the DCD to match the state of remote modem
- Ignore the DTR

Entry   AT&FE0Q0V1&C1&d0 Initialization string
Response OK   Command is valid
Entry   ATSO=1   Auto answer on 1st ring
Response OK   Command is valid

Setting Up The Communication Mode For The Enabler IIIG-BGA Module

The following example sequence provides the AT command and response for setting the Enabler IIIG-BGA module for full phone functionality, automated operator selection, 9600 baud, non-transparent mode.

Entry   AT+CFUN=1   FULL phone functionality
Response OK   Command is valid
Entry   AT+COPS=0   Automatic operator selection
Response OK   Command is valid
Entry   AT+CBST=7,0,1 9600 baud, non-transparent mode
Response OK   Command is valid

6

Integration And Testing

Integrating the Novatel Wireless M2M Enabler IIIG Module

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The Novatel Wireless M2M Enabler IIIG module has been designed to minimize the amount of time required for integration and testing the application. By being fully certified by the appropriate bodies, the Novatel Wireless M2M Enabler IIIG module provides seamless integration into the GSM network.

The integration issues for the application can be narrowed to the utilization of the AT commands and the use of the GSM functionality. Coverage and signal quality may be evaluated by using the RSSI commands. Additional network information can be determined by using AT commands.

Integration of the GPRS Packet capabilities is more complicated than using AT command sequences to initiate the connection and begin transferring data. The following Application Notes should be used to integrate the GPRS packet capabilities:

- GSM0000AN001 - Enabler-G PPP Configuration for Windows 98
- GSM0000AN002 - Enabler-G PPP Configuration for Windows 2000
- GSM0000AN008 - Enabler-G PPP Configuration for Windows XP
- GSM0000AN010 - Enabler-G PPP Configuration for PocketPC 2002
- GSM0000AN005 - Enabler-G Automated Network Connection Configuration and Use

Integrating The Novatel Wireless M2M Enabler IIIG Module

Note: Generally, all interfaces that are externally available to the end user need to be ESD-conditioned and terminated in some way. Many of these interfaces should not be connected with power applied.

At the highest level, this is done using some type of GSM test equipment (such as, Racal 6103E), a computer, and a serial interface tester. The GSM test equipment must be able to simulate a GSM call and measure the key parameters related to the module.

Additionally, the serial interfaces and some minimal SIM functionality can be verified by sending AT commands to the Novatel Wireless M2M Enabler IIIG module.

All of these conditions need to be verified at ambient as well as extreme conditions.

As part of integration, each of the following interfaces must be verified:

Information	Recommendations
SIM	The maximum line length of the SIM interface is 25.4 cm (10 inches).
The Novatel Wireless M2M Enabler IIIG module takes care of the signal conditioning	
As a minimum, an external application with a remote SIM will require a standard SIM carrier.	

Filter the SIM VCC signal with a 10 uf / 10 V capacitor to help with the line length.	
Primary and secondary serial	
Interfaces	The Novatel Wireless M2M Enabler IIIG module uses a 1.8V digital interface. The RS-232 signals must be level-shifted to get standard levels. These signals must be ESD-protected.
Reset Interface	Resets the Novatel Wireless M2M Enabler IIIG module when tied low.
Audio/Microphone	
Interface	Preliminary balancing on Novatel Wireless M2M Enabler IIIG module.
Maximum length TBD	

Testing the following parameters verifies the RF parameters that may be affected by such things as RF path loss, power supply noise, and external interference.

Functionality	Parameters to be Tested
Transmitter	Frequency Error
Phase Error	
PA Ramp	
Modulation Spectrum	
RF Power Steps	
Timing Advance	
Receiver	BER Based RX Tests (RXQUAL RXLEV)
BER Based Sensitivity	

Testing the following GSM functionality verifies proper network communication.

Functionality	Parameters to be Tested
Transmitter	Frequency Error
Phase Error	
PA Ramp	
Modulation Spectrum	
RF Power Steps	
Timing Advance	
Receiver	BER Based RX Tests (RXQUAL RXLEV)
BER Based Sensitivity	

Testing the following GSM functionality verifies proper network communication.

Functionality	Parameters to be Tested
Network Function	Synchronization and registration
Call set-up and call termination (both MT and MO calls)	
SMS and/or data calls	

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Appendix 7 - Glossary And Acronyms

AMR	Adaptive Multi-Rate
API	Application Programming Interface.
App Application	Refers to the Application which sends or receives commands/responses from the HS 3001 Module
AT Command Set	Commands issued by intelligent device to a modem to perform functions, such as to initiate call, to answer call, or to transmit data.
Bit Error Rate (BER)	Bit Error Rate
CMUX	Multiplexer protocol that operates between an MS and a TE and allows a number of simultaneous sessions over a normal serial asynchronous interface
Customer Premise Equipment (CPE)	A terminal in fixed location on the customer's premises.
Circuit Switched Data (CSD)	Data link from a terminal through the network allowing real-time, duplex connectivity at 9600 bytes/second.
dBi	Decibels referenced to an isotropic radiator
Data Communications Equipment (DCE)	Data Communications Equipment
Digital Cellular System(DCS)	A collection of services and capabilities providing flexibility of access and mobility through a combination of wireless and wire-line networks, using the 1800 MHz bandwidth.
Data Terminal Equipment (DTE)	Data Terminal Equipment
Enhanced Full Rate (EFR)	Voice (vocoder) compression algorithms which offer the highest quality voice communication.
Equipment Identity Register (EIR)	A database used to store International Mobile Equipment Identity (IMEI) of a locally issued terminal.
Equivalent Isotropic Radiated Power (EIRP)	In a given direction, the gain of a transmitting antenna multiplied by the net power accepted by the antenna from the connected transmitter.
Electromagnetic Compatibility (EMC)	The ability of a device to function satisfactorily in its electromagnetic environment without inducing intolerable disturbance to that environment (or to

	other devices)
Electrostatic Dis-charge (ESD)	Static electricity that can damage electronic equip-ment.
European Union (EU)	An organization of 15 European states whose pur-pose is to organize relations between the Member States and between their peoples.
Full Type Approval (FTA)	CDMA Full Type Approval
General Packet Radio Service (GPRS)	Standard for packet communications utilizing Code Division Multiple Access (CDMA) infra-structure.
Code Division Mul-tiple Access (CDMA)	Standard for digital communications. Allows con-sistent communications in various parts of the world despite variations in RF spectrum alloc-ations. Transferring the SIM (see below) permits users to roam by changing terminal equipment.
Home Location Register (HLR)	Stores the identity and user data for all subscribers belonging to the area of the related MSC.
International Mobile Equipment Identity (IMEI)	A unique number for each CDMA Terminal tracked by the CDMA operators in their Equipment Identity Register (EIR) database.
International Mobile Subscriber Identification (IMSI)	A unique number identifying the subscriber stored in the SIM card. Number is used in conjunction with the network for call routing.
Ki	A secret code used in authentication and encryp-tion by the terminal.
Mobile Originated (MO)	Any CDMA service originated at the mobile ter-minal.
Mobile Terminated (MT)	Any CDMA service originated from or routed through the network and sent to the mobile ter-minal.
Mobile Switching Center (MSC)	The central switch of the CDMA network. Performs call routing, collects call detail records for billing, and supervises system operations.
Non-Transparent Mode	Delivers a constantly low error rate but with a non-guaranteed throughput or delay. The Non-Trans-parent service provides a performance that is closest to using a modem over a fixed PSTN line.
Nationally Recog-nized Test Lab-oratory (NRTL)	OSHA-approved Nationally Recognized Testing Laboratory

OEM	Original Equipment Manufacturer
PA	Power Amplifier
Packet	A collection of data transmitted over a digital network in a burst
CDMA	Personal Communication Services
PDA	Personal Digital Assistant
PDU	Packet Data Unit
PPP	Point-To-Point Protocol
SIM	Subscriber Identity Module
SMS	Short Message Service
SMSC	Short Message Service Center
SUPL	Secure User Plane Location
UDP	User Datagram Protocol