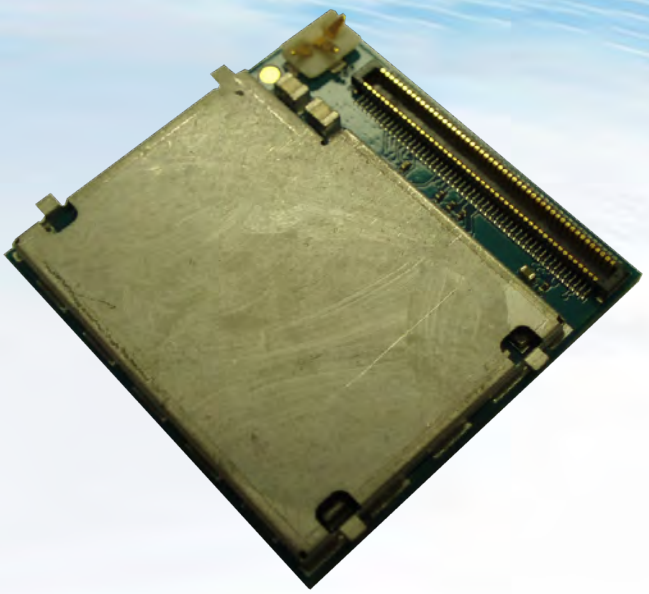
CNN04011G001

HS 3002



Integration Guide

Version: Draft

NOVATEL WIRELESS

03 July, 2013

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Regulatory Compliance

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 certifies that the HS 3002 Radio Module (FCC ID: PKRNVWCNN0403) complies with the RF requirements applicable to broadband PCS equipment operating under the authority of 47 CFR Part 24, Subpart E and Part 22 Subpart H of the FCC Rules and Regulations. This certification is contingent upon installation, operation and use of the HS 3002 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 HS 3002 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 HS 3002 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, hand held, monitor and control unit, etc. that must be considered to ensure continued compliance with FCC compliance requirements.

Important Information for Canada/USA OEM Integrators

This section provides guidance for using the HS 3002 in host devices through the FCC Permissive Change process. When utilizing the permissive change process, Novatel Wireless, the grantee, is responsible for all integrations and must be consulted on all regulatory matters involving the HS 3002.

The HS 3002 module is granted with FCC/IC modular approval for mobile[1] applications, and may be installed as a standalone[2] transmitter in final products meeting the following conditions. If the following conditions are followed, it may be used in final products without additional FCC/IC certification. Otherwise, additional FCC/IC approvals must be obtained.

- The transmitter antenna connected to the HS 3002 module must be installed to provide at least 20cm separation from the human body at all times.
- The HS 3002 module and transmitter antenna must not be co-located with any other transmitter or antenna within a host device.
- The transmitter antenna used with the HS 3002 module must not exceed the following levels:
    - GSM850/WCDMA Band 5: the maximum gain is 6.9dBi..
    - GSM1900/WCDMA Band 2: the maximum gain is 2.0dBi.
- To comply with the aspects of KDB996369, strict adherence to the design parameters in the Section Antenna And RF Signal Trace must be observed. This Section provides PCB RF trace design guidelines for the coplanar microstrip between the HS 3002 RF compression pads and the SMA coaxial connector.
- A label containing the FCC and Industry Canada IDs must be permanently affixed to the exterior of the host device into which the HS 3002 module is installed. The label may also be under a panel or battery pack if it is readily accessible and cannot be separated from the host device itself. The label must contain a statement similar to the following;
    - This device contains FCC ID: PKRNVWCNN0403
    - This equipment contains equipment certified under IC: 3229A-CNN0403

If the HS 3001 module is intended for use in a portable device, 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. Refer to FCC OET Bulletin 65 Supplement C for information about FCC RF exposure compliance requirements for mobile and portable devices. [3]

The system user manuals and other documentation must clearly indicate operating conditions that must be observed to ensure compliance with FCC/IC RF exposure guidelines and also include appropriate caution and warning statements and information.

---

[1]Mobile Device Definition – FCC defines as a transmitting antenna located at a distance ≥ 20cm from the user.
[2]Standalone is defined as a single transmitter transmitting as opposed to 2 or more transmitters transmitting simultaneously.
[3]Portable Device Definition – FCC defines as a transmitting antenna located at a distance ≤ 20cm from the user.

The host device containing the HS 3002 module may also require compliance to FCC Part 15 Subpart B – Unintentional Radiators.

Cette section fournit des directives pour l'utilisation du HS 3002 dans les dispositifs hôte sous la FCC Processus de changement permissive. Lors de l'utilisation du processus de changement permissive, Novatel Wireless, le bénéficiaire est responsable de toutes les intégrations et doit être consulté sur toutes les questions réglementaires impliquant le SH 3002.

Le module HS 3002 est accordée avec approbation modulaire de la FCC / IC pour applications mobiles[1], et peut être installé comme un émetteur autonome[2] dans les produits finaux répondant aux conditions suivantes. Si les conditions suivantes sont respectées, il peut être utilisé dans les produits finaux, sans certification FCC / IC supplémentaire. Sinon, les approbations FCC / IC supplémentaires doivent être obtenues.

- L'antenne de l'émetteur relié au module HS 3002 doit être installé pour fournir au moins 20 cm de séparation du corps humain à tout moment.
- Le module HS 3002 et l'antenne de l'émetteur ne doivent pas être co-localisé avec toute autre émetteur ou antenne à l'intérieur d'un dispositif hôte.
- L'antenne de l'émetteur utilisé avec le module HS 3002 ne doit pas dépasser les valeurs suivantes:
    - GSM850/WCDMA Band 5: le gain maximum est 6.9dBi ..
    - GSM1900/WCDMA Band 2: le gain maximum est 2.0dBi.
- Pour se conformer aux aspects de KDB996369, le strict respect des paramètres de conception dans la section antenne et piste du signal RF doivent être respectés. Cette section fournit des lignes directrices de conception de piste RF de PCB pour la micro piste coplanaires entre le tampons de compression RF du HS 3002 et le connecteur coaxial SMA.
- Une étiquette contenant le numero d'identification de la FCC et Industrie Canada doit être apposée de façon permanente à l' extérieur du dispositif hôte dans laquelle le moduleHS 3002 est installé. L'étiquette peut être aussi sous un panneau ou une batterie si elle est facilement accessible et ne peut pas être séparé du dispositif hôte lui-même. L'étiquette doit contenir une déclaration similaire à la suivante;
    - Cet appareil contient FCC ID: PKRNVWCNN0403
    - Ce dispositif contient du matériel certifié sous IC: 3229A-CNN0403

Si l'une de ces conditions n'est pas remplie, des informations supplémentaires devraient être obtenues auprès de la FCC ou un laboratoire d'essai qualifié par la FCC.

[1]Définition de dispositif mobile – la FCC définit comme une antenne d'émission située à une distance ≥ 20cm de l'utilisateur.
[2]Autonome est défini comme un seul émetteur transmettant au lieu de deux ou plusieurs émetteurs émettant simultanément.

Si le module HS 3002 est destiné à être utilisé dans un dispositif portable, l'intégrateur OEM est responsable de l'approbation pour satisfaire aux exigences SAR de la FCC / IC. Reportez-vous au bulletin 65 OET supplement C de la FCC pour obtenir des informations sur les exigences de conformité sur les exposition RF de la FCC pour des dispositifs mobile et portable.[1]

Les manuels d'utilisation du système et d'autres documents doivent indiquer clairement les conditions de fonctionnement qui doivent être respectées pour assurer la conformité avec les lignes directrices de la FCC / IC et aussi inclure les mises en garde et avertissements appropriées. Le dispositif hôte contenant le module HS 3002 peut également exiger le respect de la partie 15 de la FCC Sous-section B - rayonnement non intentionnel.

Industry Canada

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil est conforme aux normes d'Industrie Canada exempts de license(s) RSS. Son fonctionnement est soumis aux deux conditions suivantes : (1) cet appareil ne doit pas provoquer d'interférences, et (2) cet appareil doit accepter toute interférence, y compris les interférences pouvant provoquer un fonctionnement indésirable de l'appareil.

Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.

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.

[1]Définition de dispositifportable – la FCC définit comme une antenne d'émission située à une distance ≤ 20cm de l'utilisateur.

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.

If the FCCID of the module is not visible when installed in the host platform, then a permanently attached or marked label must be displayed on the host unit referring to the module.

The label should contain wording such as:

Contains FCC ID: Mxxxxxxxx

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.

CE MARKING - R&TTE DIRECTIVE

The HS 3002 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. It is the responsibility of the integrator to ensure that the device incorporating the HS 3002 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 HS 3002 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.

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 HS 3002 modules are designed and manufactured to comply to the European Union Directive 2002/95/EC for the Restriction of Hazardous Substances (RoHS).

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 HS 3001 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. This product does not contain consumer-serviceable components.

The HS 3002 module may not be used in an environment where radio frequency equipment is prohibited or restricted in its use. This includes aircrafts, airports, hospitals, and other sensitive electronic areas.

Do not operate RF devices in an environment that may be susceptible to radio interference resulting in danger, specifically;

- Areas where prohibited by the law.
    - Follow any special rules and regulations and obey all signs and notices. Always turn off the host device when instructed to do so, or when you suspect that it may cause interference or danger.
- Where explosive atmospheres may be present.
    - Do not operate your modem in any area where a potentially explosive atmosphere may exist. Sparks in such areas could cause an explosion or fire resulting in bodily injury or even death. Be aware of and comply with all signs and instructions.
- Users are advised not to operate the modem while they are at a refueling point or service station.
    - Users are reminded to observe restrictions on the use of radio equipment in fuel depots (fuel storage and distribution areas), chemical plants or where blasting operations are in progress.
- Areas with a potentially explosive atmosphere are often but not always clearly marked.
    - Potential locations can include gas stations, below deck on boats, chemical transfer or storage facilities, vehicles using liquefied petroleum gas (such as propane or butane), areas where the air contains chemicals or particles, such as grain, dust or metal powders, and any other area where you would normally be advised to turn off your vehicle engine.
- Near Medical and life support equipment.
    - Do not operate your modem in any area where medical equipment, or life support equipment may be located, or near any equipment that may be susceptible to any form of radio interference. In such areas, the host communications device must be turned off. The modem may transmit signals that could interfere with this equipment.
- On an aircraft, either on the ground or airborne.
    - In addition to FAA requirements, many airline regulations state that you must suspend wireless operations before boarding an airplane. Please ensure that the host device is turned off prior to boarding an aircraft in order to comply with these regulations. The modem can transmit signals that could interfere with various on-board systems and controls.

- While operating a vehicle
    - The driver or operator of any vehicle should not operate a wireless data device. Doing so will detract from the driver or operator's control and operation of that vehicle. In some countries, operating such communication devices while in control of a vehicle is an offense.

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.

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1

Introduction

Product Overview

Technical Specifications

Reference Documents

Typical Usage

Product Overview

The HS 3002 modem is a compact, wireless OEM module that utilizes the Universal Mobile Telecommunications System (UMTS) communications standard to provide two-way wireless capabilities. The HS 3002 module is a fully approved UMTS device, enabling application-specific, two-way communication and control.

The small size of the HS 3002 module allows it to be integrated easily into the application and packaging.

Figure 1-1 HS 3002 Module

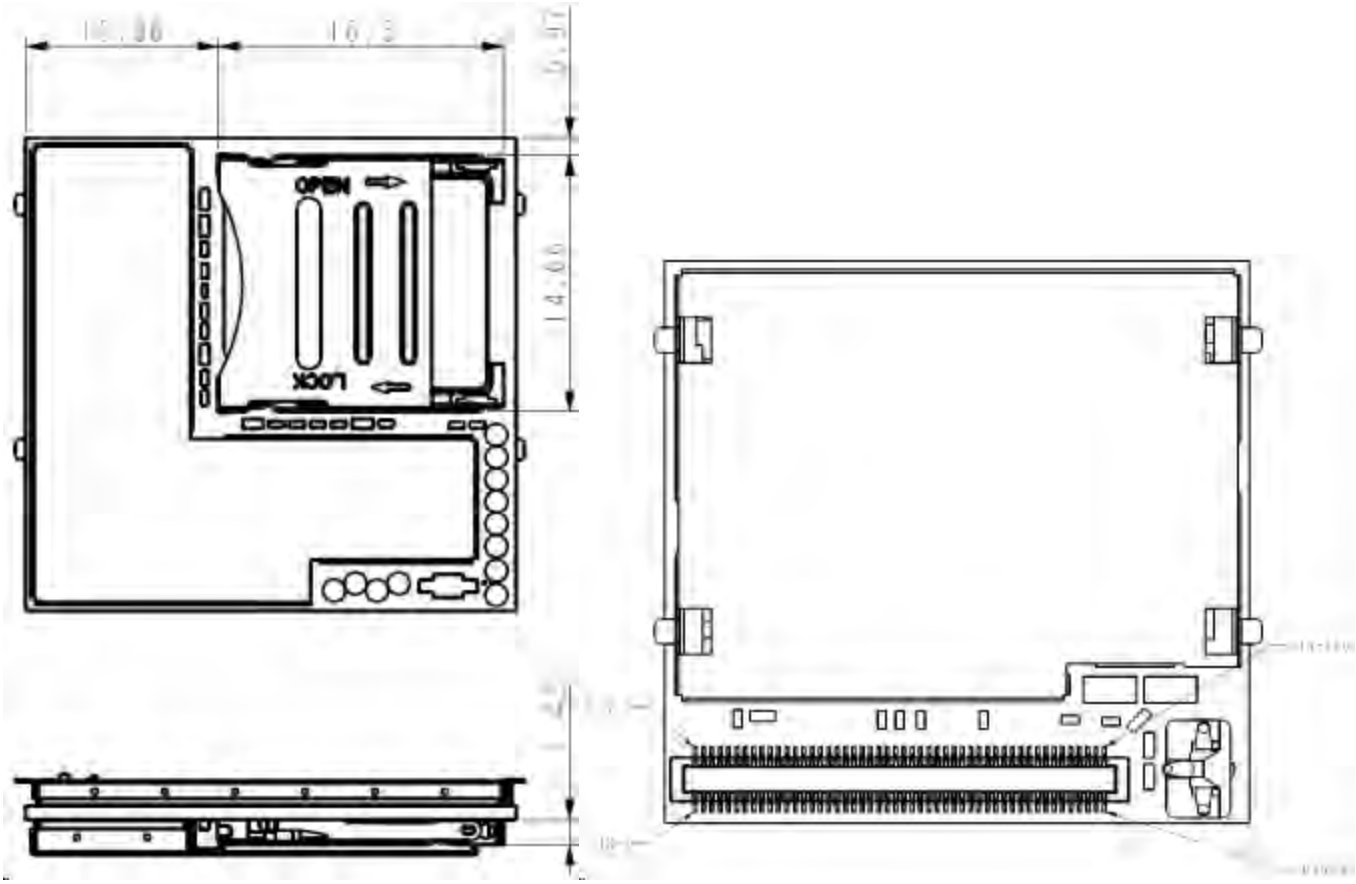


Figure 1-2 HS 3002 Module Schematic

Technical Specifications

Housing

- Size (L x W x H): 28.0 mm x 27.0 mm x 4.50 mm
- Weight: 5 grams

Interfaces

- Host Interface: Serial Interface
- Data input/output interface: 100 position 0.4 mm pitch connector (Molex P/N 55909-1074)
- Primary serial port: V.24 protocol, 1.8V levels, UART implementation, Hard-ware flow control
- USB port: USB serial port and USB Debug (USB Debug is Novatel Wireless M2M Use only)

Application Interface

- USB: 3.3V
- VBUS: 5.0V
- Mic Bias Out: 1.8V @ 1.5 mA max.
- Audio Mic Inputs: 1.0 Vp-p ±12%
- Ear Audio Out: 1.11 – 1.40 VRMS into 32 Ω (1.25 VRMS typical)
- Headset Out L&R: 0.531 to 0.668 VRMS into 16 Ω (0.595 VRMS Typical)

Power

- Electrical Power: 3.4 to 4.4 Vdc (vbat)

  Supply Vripple must be less than

- GPIO: Up to 8 GPIO
- Audio: Analog and Digital audio
- Voice: Supports Handset and Headset audio interfaces
- Antenna Interface: B2B Spring contact
- Command protocol: Novatel Wireless M2M Packet API, AT Command set
- Reference clock: 32 kHz output reference clock (accessible via 100-pin connector)
- ADC: 2 ADC inputs
- Logic:
  - UART1
  - PCM
  - Digital Audio
  - GPIO
  - PWON
  - Power Control

Outputs

- Handset earphone outputs (EARP, EARN pins)
- Headset 32 Ω stereo outputs (HSOL, HSOR pins)

Mechanical: Storage And Transportation

- Transportation vibration, packaged: ASTM D999
- Drop, packaged: ASTM D775 method A, 10 drops

Mechanical: Operational

- Operational vibration: Random IEC60068-2-64 / MIL-STD-202G Method 214A
  50-2000 Hz, 7.56 GRMS, 3 Axis, 8 Hours per axis

25 mV across all frequencies

- Peak currents and average power dissipation: Refer to the Operating Power table in the Technical Specifications for peak currents and average power dissipation for various modes of operation.

Radio Features

- Frequency bands: WCDMA B5 (850 MHz) +B2 (1900 MHz) (CNN0403)
  WCDMA B1 (2100MHz) + B8 (900 MHz) (CNN0402)
- Radio Mode: GPRS/EDGE 850 & 1900 (CNN0403)
  GPRS/EDGE 900 and 1800 (CNN0402)
- Chipset: Qualcomm QSC6270

Audio Features

- Headset Microphone biasing
- Handset Microphone biasing
- Headset Plug/Unplug detection
- Handset microphone input (MICIN, MICIP pins)
- Headset microphone input (HSMIC pin)

Environmental

- Compliant Operating Temperature: -20 °C to 60 °C
- Operating Temperature
- Storage Temperature: -40 °C to 85 °C
- Humidity: Up to 95% non condensing
- Emissions: FCC 47 CFR Parts 2,15,22 & 24

Packet Data Transfer

- Protocol
- Short Message Services: Text, MO/MT

Regulatory

- Agency approvals: FCC Certification
  Industry Canada
  PTCRB
  CE
  GCF

Reference Documents

- CNN040xAT001 - HS 3002 AT Command Reference
- CNN040xTG001 - HS 3002 Transition Guide
- ENF0000SD001 - HDK Guide
- CNN030xAN001- Using Digital Audio on the HS 3001/3002

Typical Usage

The following applications can use the HS 3002 module for transmitting/receiving data/voice:

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

2

Module Power

Operating Power

Operating Power

The HS3002 module requires an in/out voltage of 3.4V to 4.4V. The supply ripple must be less than 25mV across all frequencies.

Typical Input Current

Test Conditions:

Typical Results @ 3.7 V, 25 deg C, with 1000 µF at connector input on V_{BAT} and RF terminated into a 50 Ω resistive load.

Band		Mode	Avg (mA)	Peak (mA)	Notes
B2 (1900 MHz)	HSPA	WCDMA Radio Acccess Bearer channel of RMC12 Max Power 23 dBm	540		
B5 (850 MHz)	HSPA	WCDMA Radio Acccess Bearer channel of RMC12 Max Power 23 dBm	525		
GSM850	GPRS			2000	
GSM850	EGPRS			1200	
GSM1900	GPRS			1300	
GSM1900	EGPRS			900	
*4:1 VSWR					

3

Interfaces

Module Mounting to Host Board (Reference)

Mounting Tab Soldering Guidelines

Connection Options

RF Connection Options

I/O Connector Pin Assignments

Figure 3-1 Front of Module (Board-to-Board RF Conn. Version)

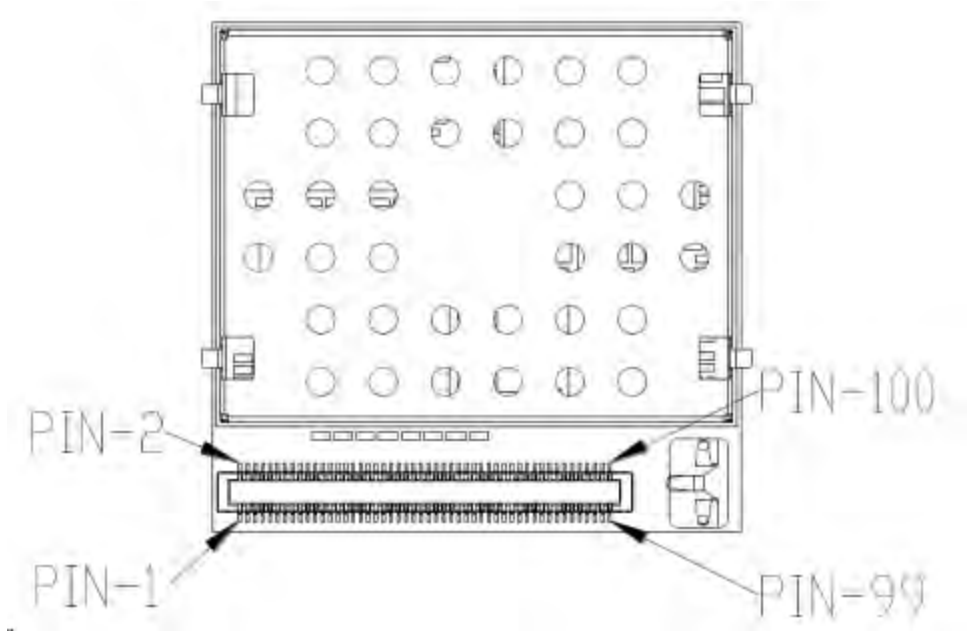


Figure 3-2 Pin 1 Reference, 100-Pin I/O Connector

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.

Do not add solder paste to mounting pads, RF connector, or shield pads.

The only portion recommended for thermal relief is along the outer edge of each pad, where a soldering iron would be placed. The rest of the pad should be solid flood to the copper ground underneath the module. (See Figure 5) This is critical for helping heat dissipation.

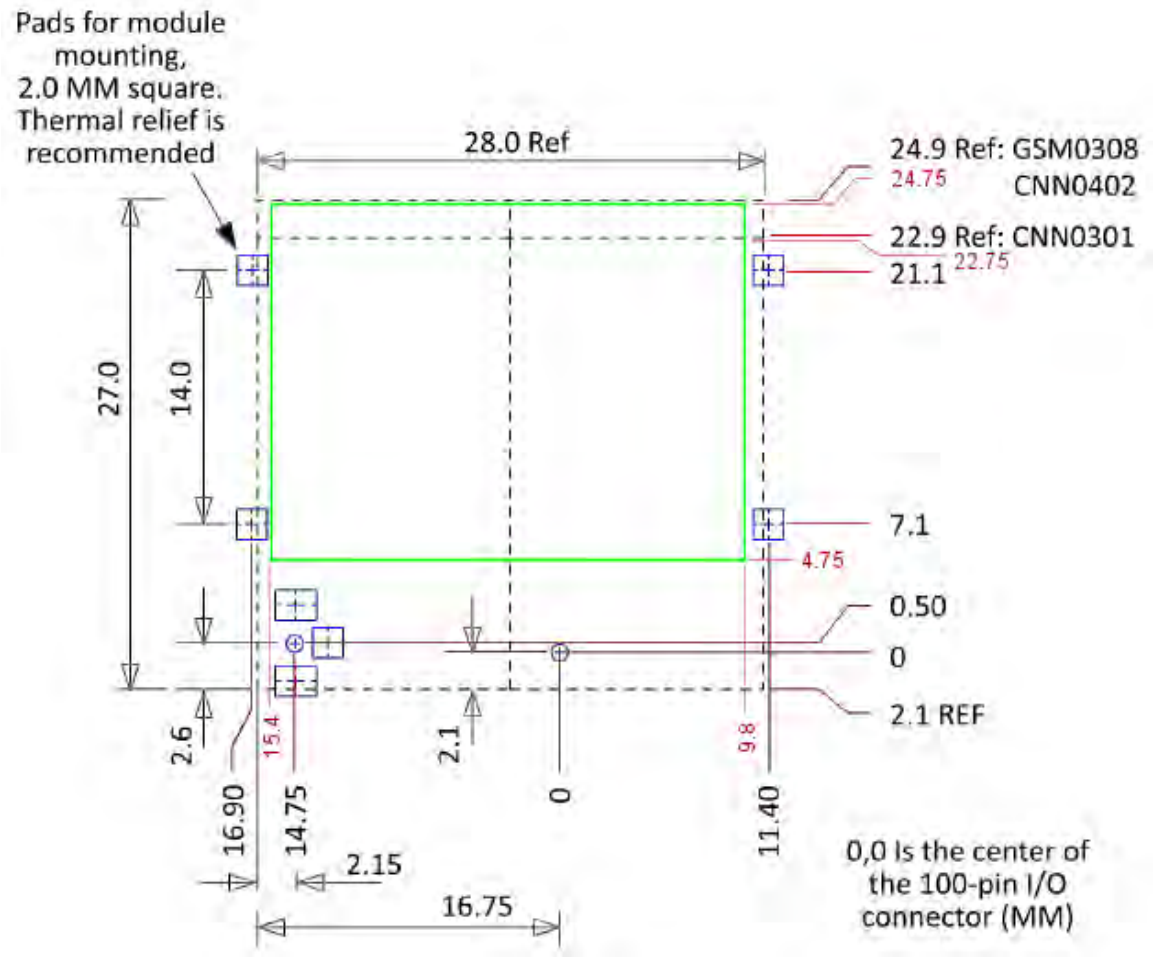


Figure 3-3 Host Board Layout

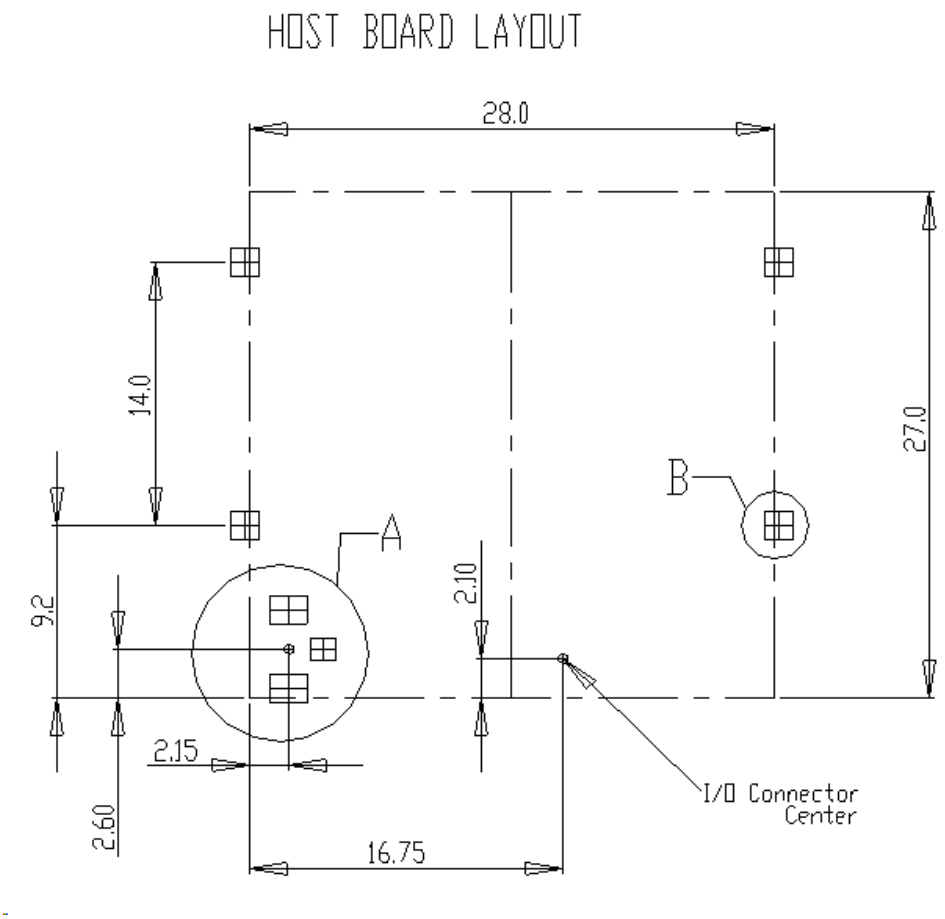


Figure 3-4 Module Mounting

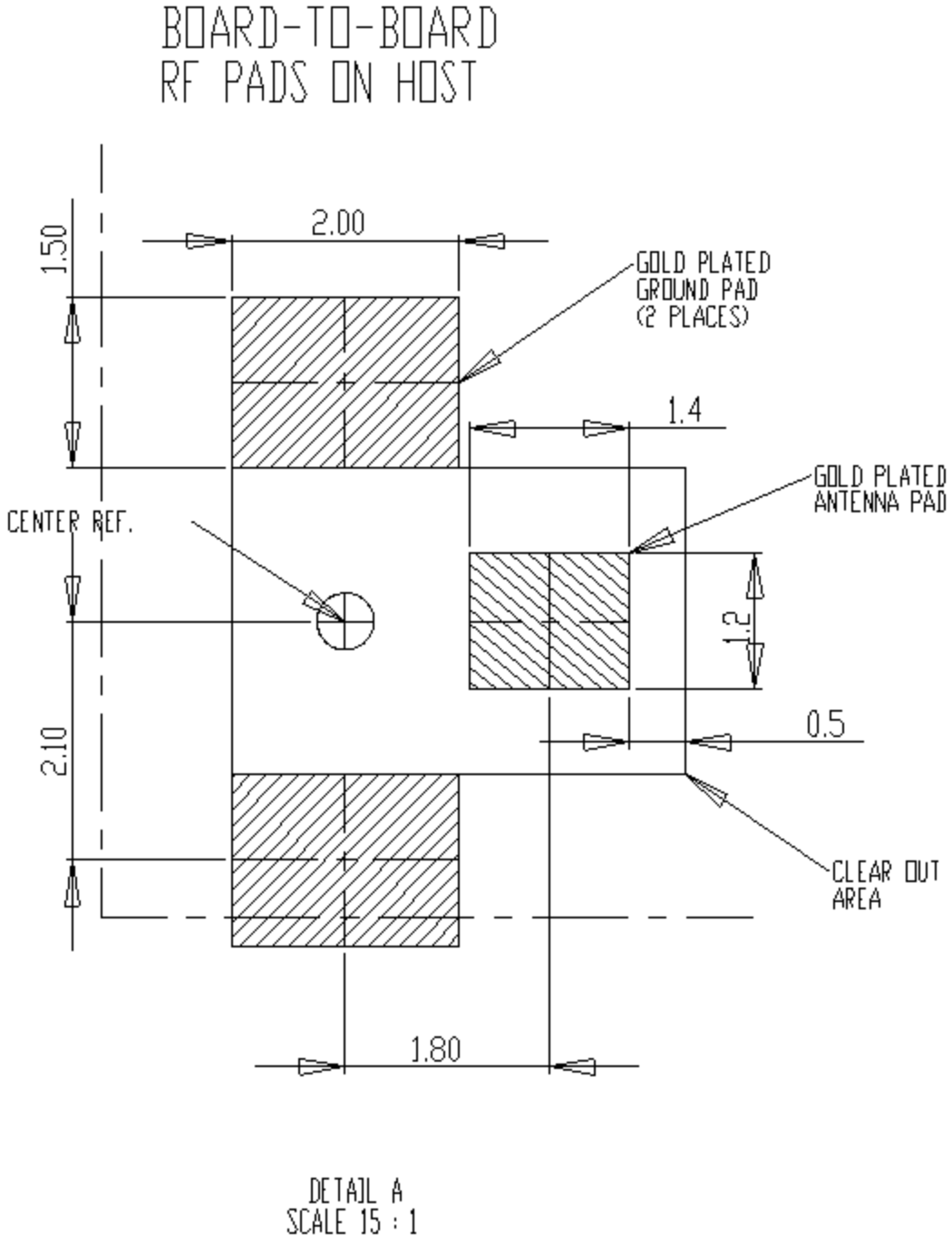


Figure 3-5 Host Pads for Board-To-Board RF Connector

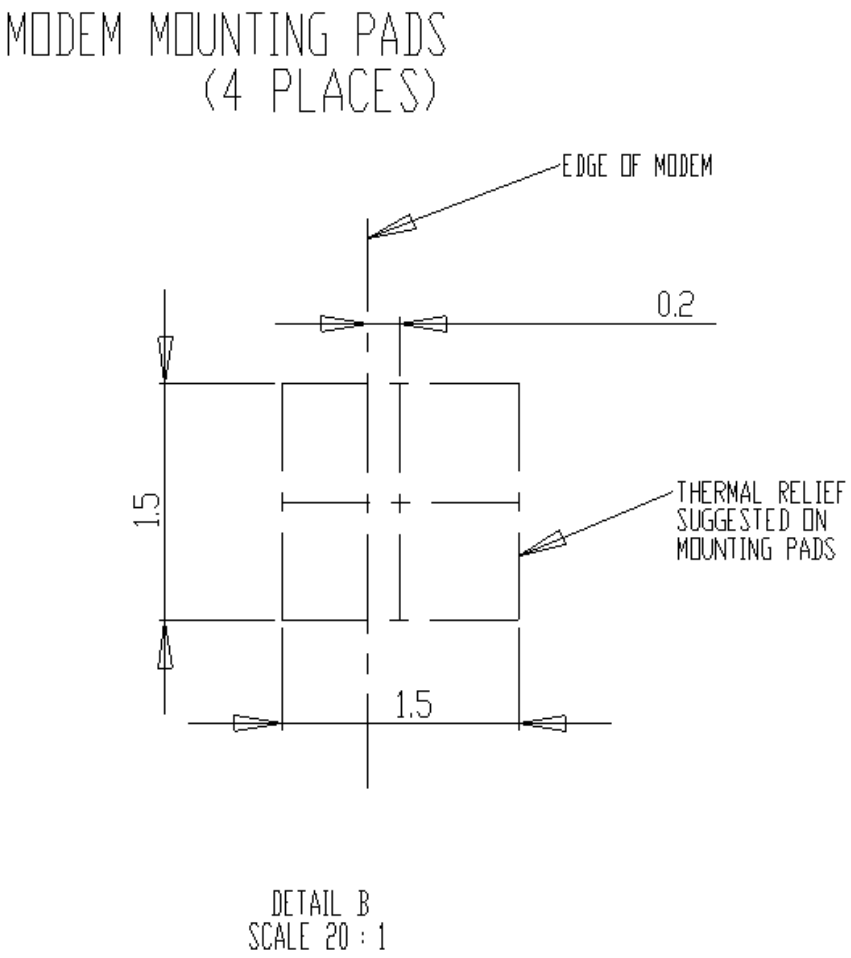


Figure 3-6 Modem Mounting Pads

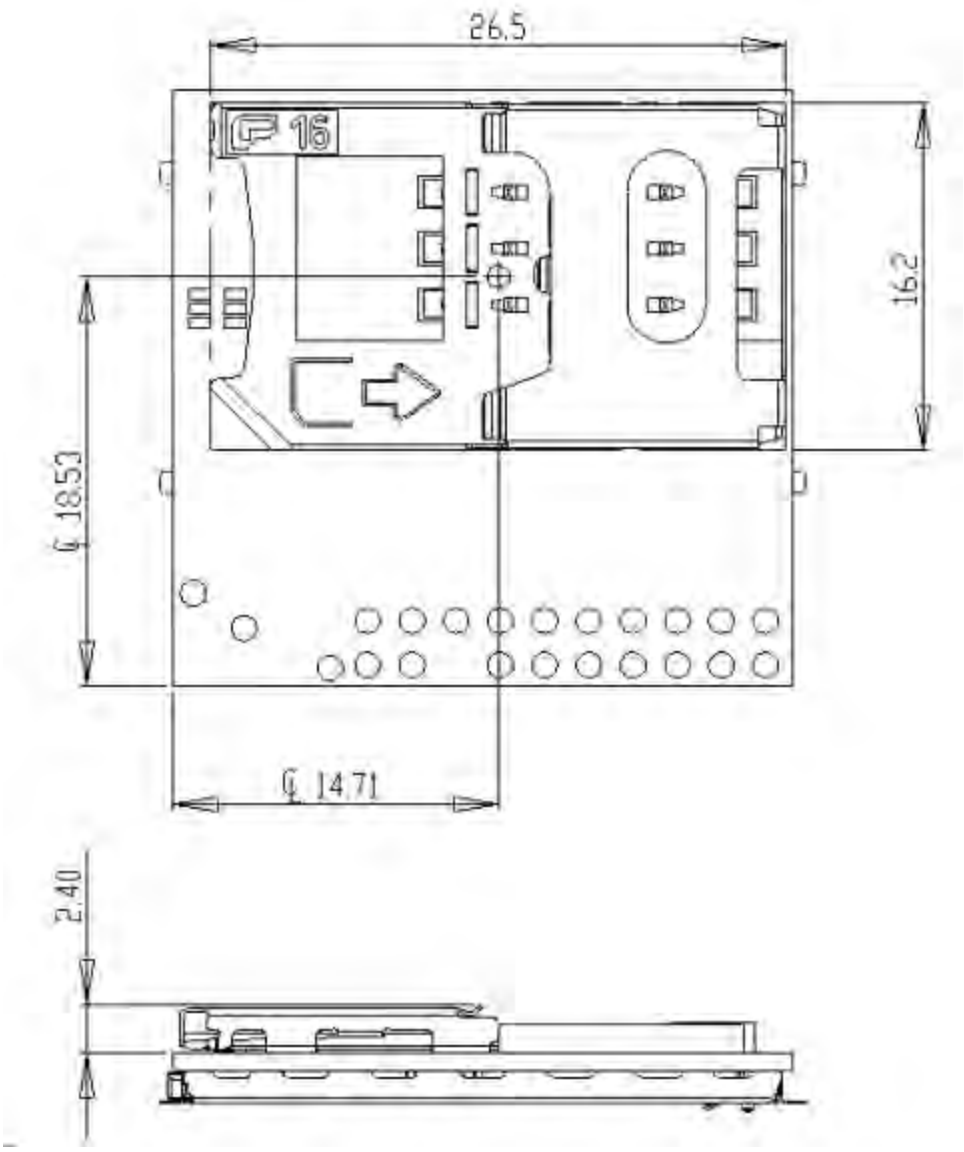


Figure 3-7 Remote USIM/SIM holder NEED NEW DWG

Mounting Tab Soldering Guidelines

Take care not to apply excessive solder during module mounting. Solder bridging to internal components can occur if an overly large iron tip is used and held against the vertical shield walls while solder is applied at the junction between iron and module. Coverage of the outer ¾ of the tab is sufficient for securing the module. Please see the diagram below:

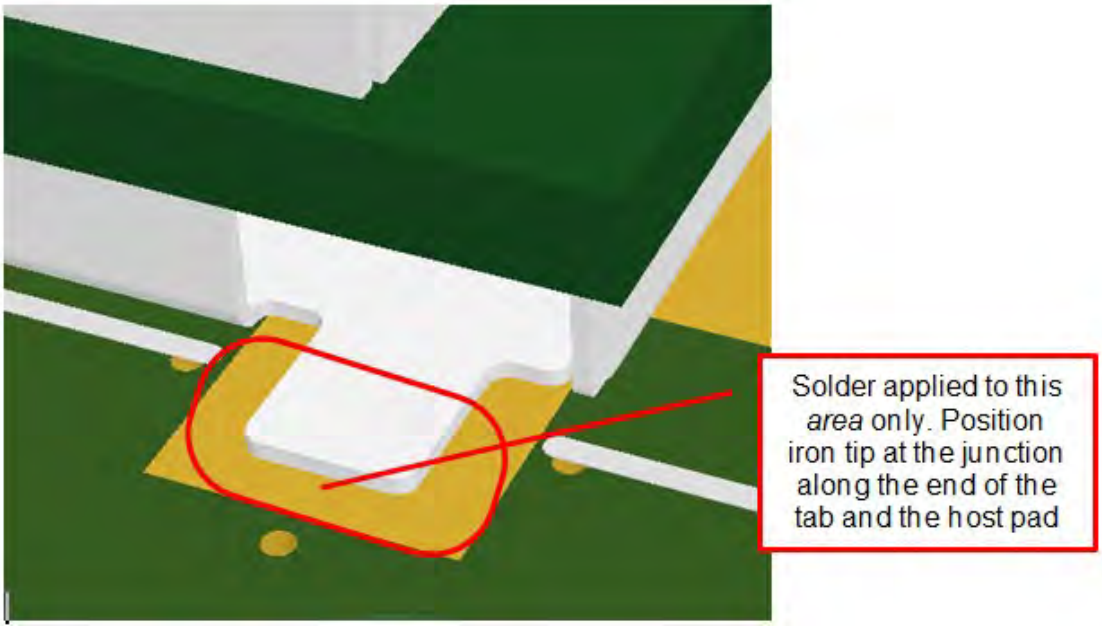


Figure 3-8 Module Tab Soldering

The iron tip should not exceed the size of that shown below for the Metcal SSC-x36A series tip.

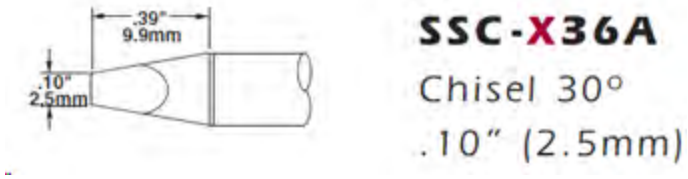


Figure 3-9 Recommended Tip Size

Connection Options

Main Interface (100 Pin)

On The Modem

100-Pin I/O Connector, Plug, SMT, Dual Row, and 0.4 mm Pitch

- Novatel Wireless M2M Part Number = CON-1040-0100
- Molex Part Number = 55909-1074

On The Host PCB

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

- Novatel Wireless M2M Part Number = CON-1040-0101
- Molex Part Number = 51338-1074

The mated height of the two connectors is 1.50 mm.

Remote USIM/SIM Interface (Optional)

The HS3002 has an internal (3FF) micro USIM holder on board the module. However, the integrator can choose to use a remote USIM interface which can be a Mini SIM. The integrator can use any compatible Mini SIM with the HS3002 For example;

Suyin P/N: 254021MA006S162ZL

The choice of any remote Mini SIM must adhere to the guidelines defined in Section 6.3.22 of this integration guide.

RF Connection Options

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.

I/O Connector Pin Assignments

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

Pin	Function	Description	Notes
01	VBUS	USB Power	
02	GND	Ground	
03	VBUS	USB Power	
04	GND	Ground	
05	USB_DP	USB Data (+)	
06	LED_SINK	Current sink for LED	
07	USB_DM	USB Data (-)	
08	Reserved	N/A	Do Not Connect
09	Reserved	N/A	Do Not Connect
10	Reserved	N/A	Do Not Connect
11	UART_RTS	UART1 RTS (input)	
12	PCM_DIN	Digital Audio I/F Data In	
13	UART_CTS	UART1 CTS (output)	
14	PCM_CLK	Digital Audio Clock	
15	UART_RX	UART1 RX (output)	
16	PCM_SYNC	Digital Audio Interface Sync	
17	UART_DTR	Data Terminal Ready	
18	PCM_DOUT	Digital Audio I/F Data Out	
19	UART_DCD	Data Carrier Detect	
20	Reserved	N/A	Do Not Connect
21	UART_TX	UART1 TX (input)	
22	Reserved	N/A	Do Not Connect
23	UART_RING	Ring Indicate	
24	Reserved	N/A	Do Not Connect
25	UART_DSR		
26	Reserved	N/A	Do Not Connect
27	Reserved	N/A	Do Not Connect
28	Reserved	N/A	Do Not Connect
29	Reserved	N/A	Do Not Connect
30	Reserved	N/A	Do Not Connect
31	Reserved	N/A	Do Not Connect
32	Reserved	N/A	Do Not Connect
33	Reserved	N/A	Do Not Connect
34	Reserved	N/A	Do Not Connect
35	PHON	"Phone on" - momentary low to activate	
36	Reserved	N/A	Do Not Connect
37	ON\OFF	Power Control Switch Input (Selectable Logic via Pin 85)	
38	Reserved	N/A	Do Not Connect
39	Reserved	N/A	Do Not Connect

Pin	Function	Description	Notes
40	Reserved	N/A	Do Not Connect
41	Reserved	N/A	Do Not Connect
42	Reserved	N/A	Do Not Connect
43	Reserved	N/A	Do Not Connect
44	ADC2	Analog Input #2	
45	Reserved	N/A	Do Not Connect
46	Reserved	N/A	Do Not Connect
47	HSDET	Headset Detect	
48	Reserved	N/A	Do Not Connect
49	Reserved	N/A	Do Not Connect
50	Reserved	N/A	Do Not Connect
51	Reserved	N/A	Do Not Connect
52	Reserved	N/A	Do Not Connect
53	MICBIAS	Microphone Bias	
54	GND	Ground	
55	HSMIC+	Headset Microphone (+)	
56	CLK32K_BUF	Buffered 32.768 kHz clock output	
57	HSOL	Headset Out Left (+)	
58	GPIO_4	General Purpose IO	
59	HSOR	Headset Out Right (+)	
60	GPIO_3	General Purpose IO	
61	Reserved	N/A	Do Not Connect
62	GPIO_2	General Purpose IO	
63	MICBIAS	Microphone Bias	
64	GPIO_1	General Purpose IO	
65	MICIP	Microphone +	
66	GPIO_7	General Purpose IO	
67	MICIN	Microphone -	
68	GPIO_5	General Purpose IO	
69	GND	Ground	
70	GPIO_6	General Purpose IO	
71	EARP	Earphone +	
72	GPIO_8	General Purpose IO	
73	EARN	Earphone -	
74	ADCIN1	ADC IN 1 (Analog input #1)	
75	GND	Ground	
76	SIM_VDD	SIM VDD supply voltage	
77	VRIO_MSME1.8	Reference Voltage (<5 mA) for external interfaces	
78	SIM_CLK	SIM Clock	

Pin	Function	Description	Notes
79	Reserved	N/A	Do Not Connect
80	SIM_RST	SIM Reset	
81	Reserved	N/A	Do Not Connect
82	SIM_IO	SIM IO Data	
83	Reserved	N/A	Do Not Connect
84	SIM_DTC	SIM Detect	
85	PSLOGIC	On/Off logic select	
86	GND	Ground/Power Return/Shield	
87	VBAT	Power Input	
88	GND	Ground	
89	VBAT	Power Input	
90	GND	Ground	
91	VBAT	Power Input	
92	GND	Ground	
93	VBAT	Power Input	
94	GND	Ground	
95	VBAT	Power Input	
96	GND	Ground	
97	VBAT	Power Input	
98	GND	Ground	
99	VBAT	Power Input	
100	GND	Ground	

4

Hardware Design Guidelines

General Design Guidelines for Using HS 3002 Modules

Circuit Protection

Control Connector Signal Descriptions And Functions

Circuit Protection

General Design Guidelines For Using HS 3002 Modules

The following guidelines are provided in an effort to allow HS 3002 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 HS 3002 module is a very compact, high performance design, and very easy to interface into the final product. In order to realize its full potential, designers should pay close attention to the following:

- Ground structures
- The routing of RF and Digital traces
- 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, you should try to utilize these sound engineering principles whenever possible.

Advanced Tips For An RF Friendly Layout

Ground Plane

To ensure the lowest possible EMI emissions and maximum thermal conductivity, it is recommended that all metal tabs on the cellular 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 power traces and vias under the cellular module to allow for as much ground plane as possible. An example of a good ground structure and pad layout is shown below.

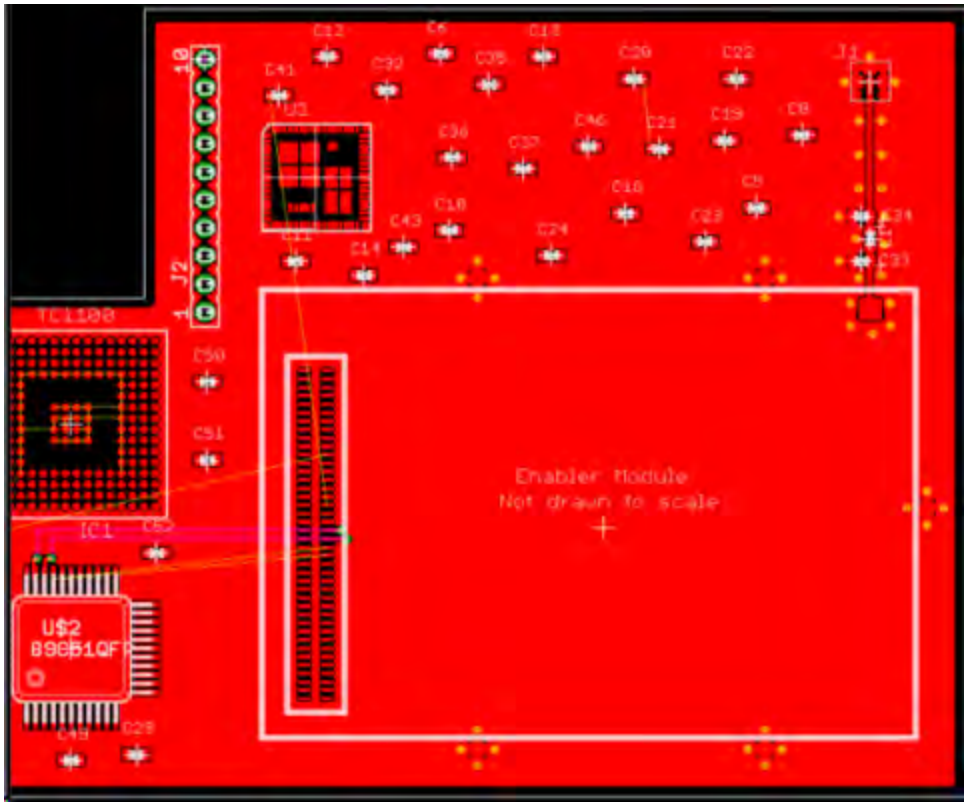


Figure 4-1 Example of good ground plane

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 the following figureis satisfactory 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 cellular 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.

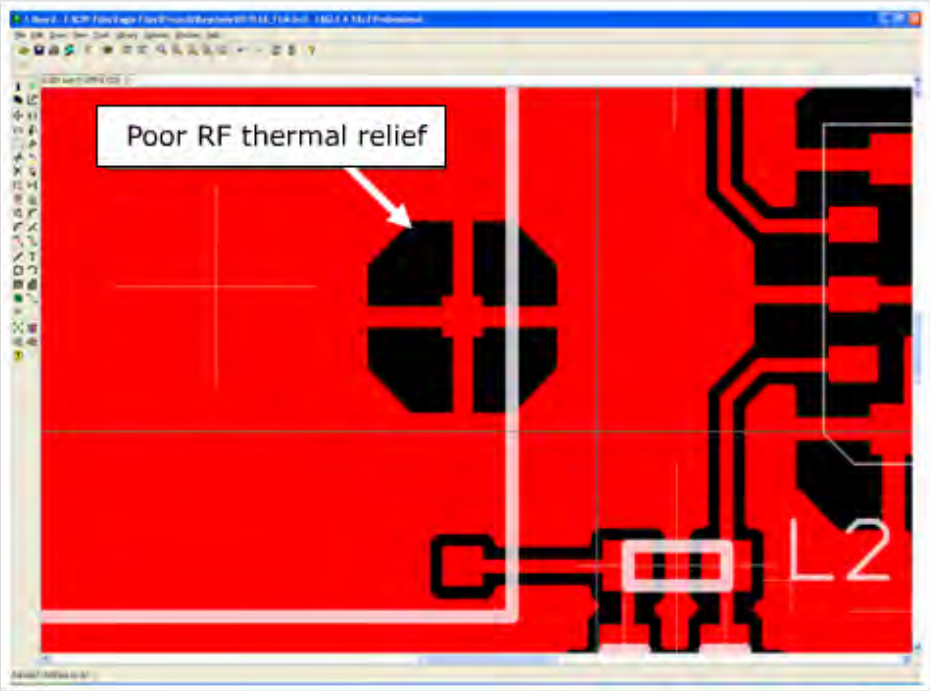


Figure 4-2 Example of a POOR RF Thermal Relief

If thermal relief is necessary, it is recommended that you use short, fat traces similar to those shown in following figure. 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 cellular module shield tabs.

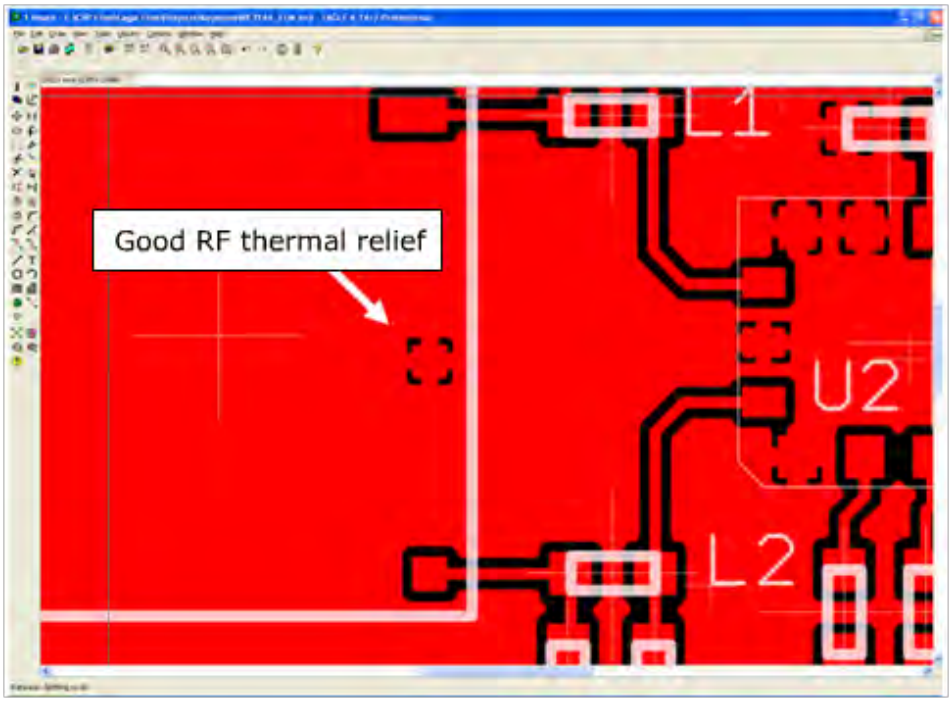


Figure 4-3 Example of a GOOD RF Thermal Relief

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 standard microstrip, given sufficient clearance),or routed into internal layers to keep the top layer continuous around and underneath the cellular 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 provided at no or minimal additional cost.

For minimum RF emissions due to the fundamental frequency of operation, the cellular 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

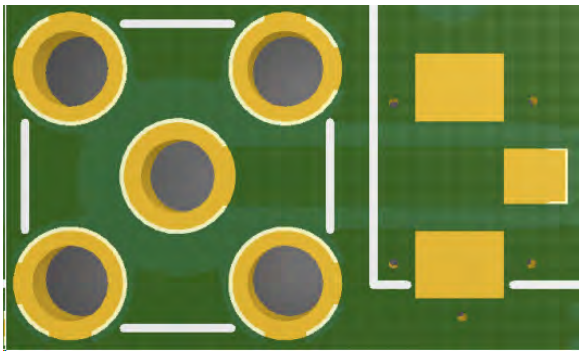
applications where antenna quality is less than ideal, it is recommended to have a low pass filter (Pi structure with N=3) in the RF path to the antenna. This is a secondary plan should there be a need to lower harmonic levels at frequencies above the PCS band. The pad structure may also be used to match 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 cellular module and the antenna is very lossy, therefore, the length of this cable should be kept as short a possible.

The following design parameters are for the coplanar microstrip between the Module RF compression pads and the SMA coaxial connector.

Note – the use of a through-hole SMA connector will affect impedance. The connector body must allow at least as twice as much vertical clearance as the height to the microstrip reference layer. There should be ample clearance to all layers from the center pin.

The coplanar waveguide microstrip details are shown below.



The construction details and path adjustment for 50Ω is shown in the following diagram and table.

Imp	Lyr	Type	Image	Foil	Plt (Mil)	Thk (Mil)	Er	Name
	SST					0		- -
	SMT					0.5		- -
2xΩ	L1	Mixed		1oz	1.2	10	4.30	IT-180A 0.010 CA S1/S1 24X18
	L2	Mixed		1oz	0			
							3.90	IT-180A 106 18X24
						5.01	4.05	IT-180A 1080 18X24
						24	4.40	IT-180A 0.024 CA S1/S1 24X18
							4.05	IT-180A 1080 18X24
						5.01	3.90	IT-180A 106 18X24
	L3	Mixed		1oz	0			
1xΩ	L4	Mixed		1oz	1.2	10	4.30	IT-180A 0.010 CA S1/S1 24X18
	SMB					0.5		- -
	SSB					0		- -

Impedance Table

Layer	Impedance Requirement (Ω)	Tolerance (Ω)		Type	Upper Ref	Lower Ref	Finished Line Width (mil)	Finished Spacing (mil)	Impedance Simulation (Ω)
		+	-						
L1	50	5.0	5.0	Coplanar coated microstrip		L3	58.10	20	50.8

VBAT Input

The HS 3002 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 cellular module 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 following figure.

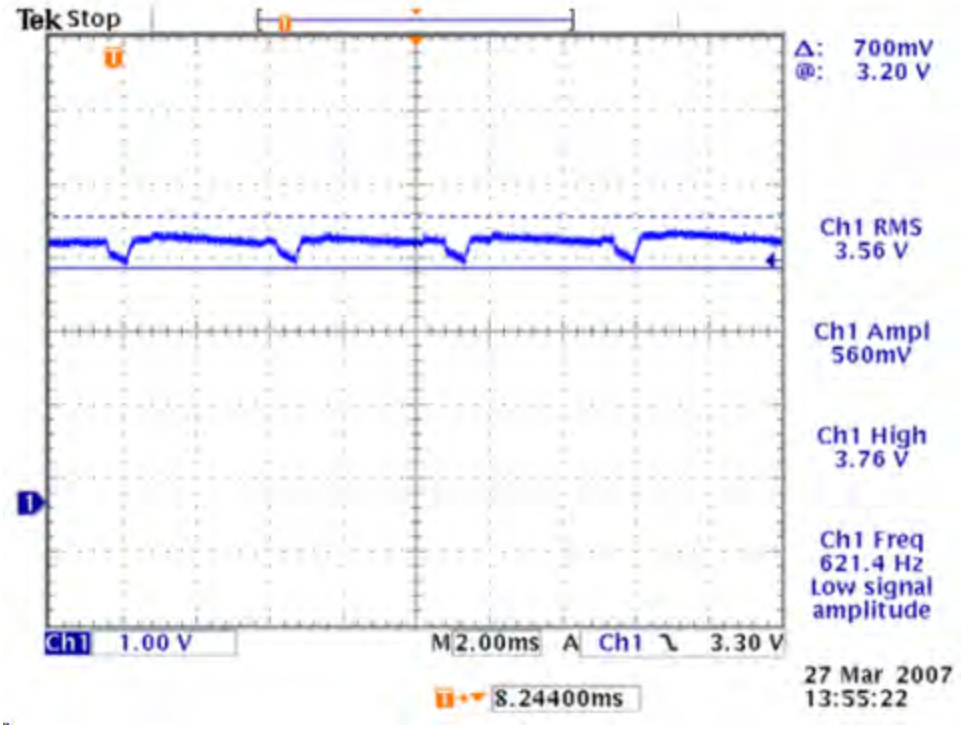


Figure 4-4 Example of VBAT Voltage Droop

If the VBAT drops too low, the cellular module will reset. To minimize the trace loss, it is suggested to use a larger trace that spans several pins as shown in following figure. Any concern about solderability can be mitigated by using solder mask with a cutout for the power supply pins (in the white outline). The layout should provide sufficient trace width over the entire trace from the cellular module 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 cellular module, sufficient bulk decoupling capacitance is required at the Vbat input to the cellular module. It is suggested to use at least two 1000 uF, low ESR, tantalum capacitors located very close to the cellular 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.

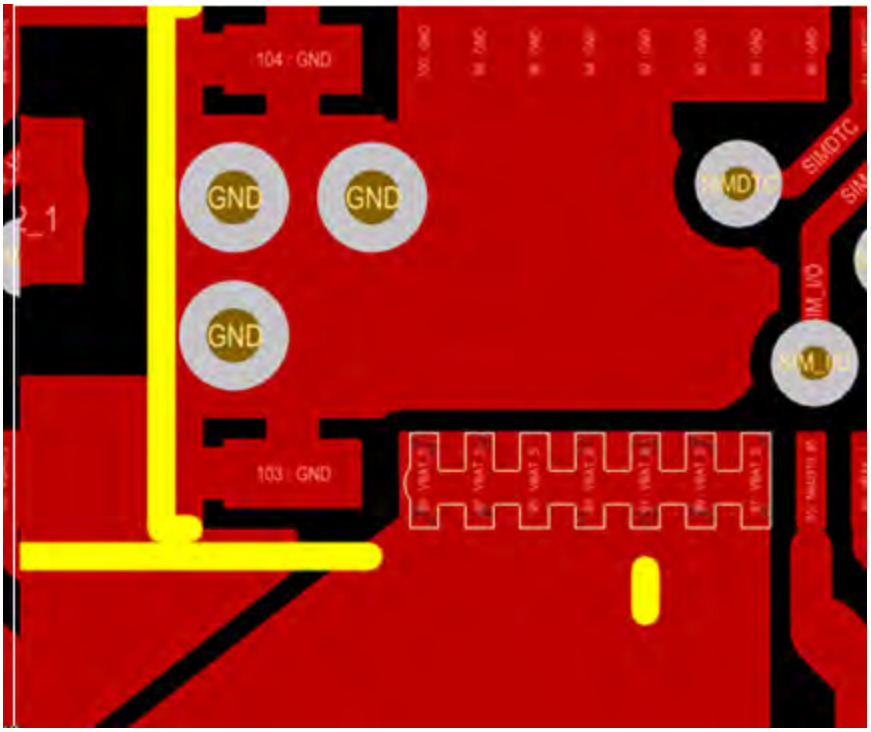


Figure 4-5 Example of GOOD VBAT layout

Audio Reference Design

The audio quality is dependent on the circuit design and layout. As an aid to obtaining good audio quality, a reference design has been included below.

Audio Schematics

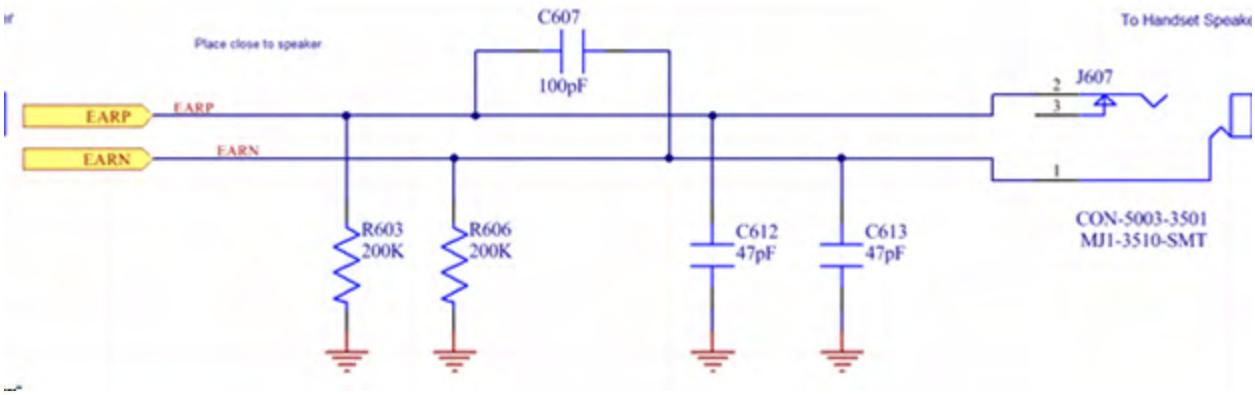


Figure 4-6 Handset Speaker Schematic

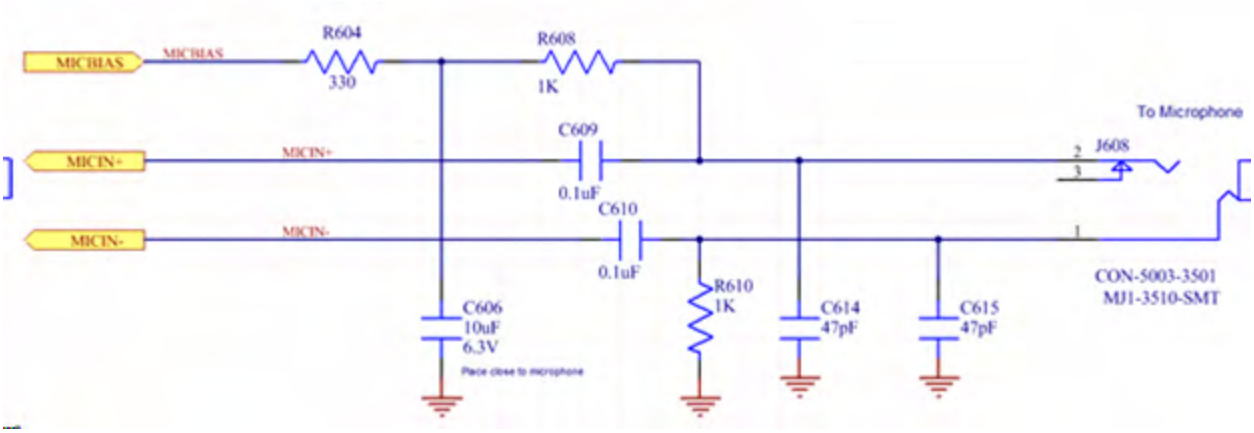


Figure 4-7 Handset Microphone Schematic

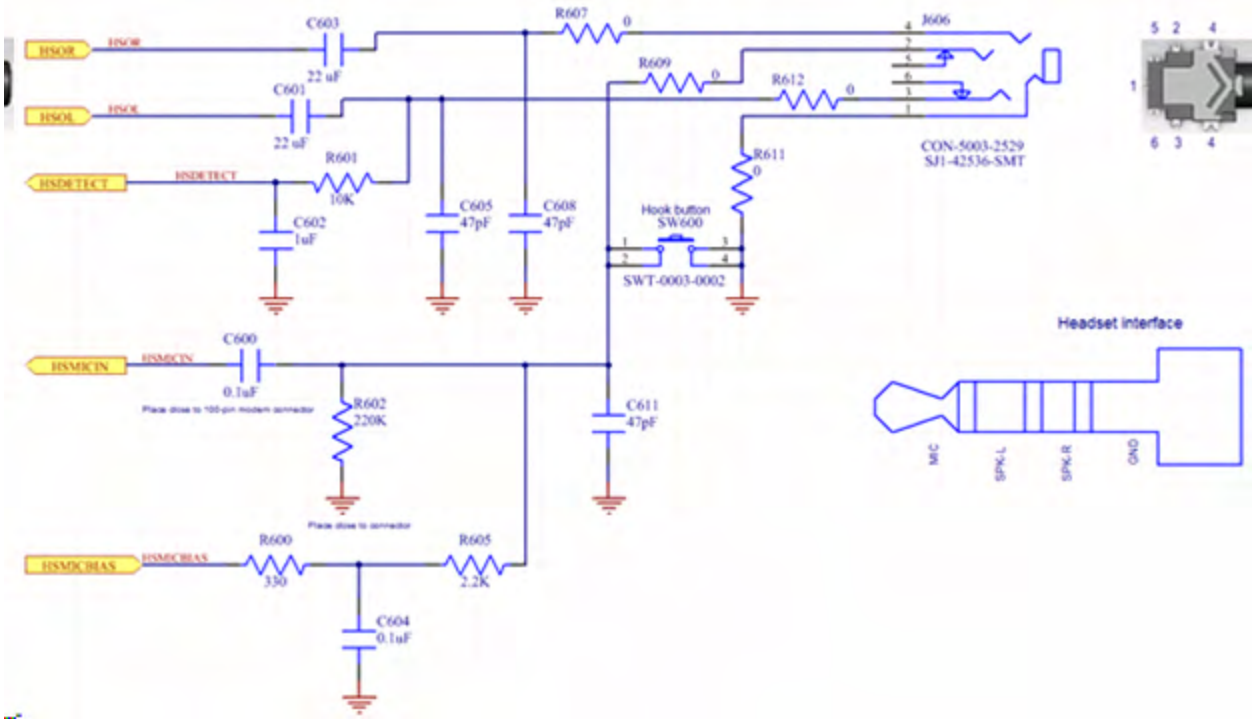


Figure 4-8 Headset Schematic

Circuit Protection

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

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

Series resistors (typically 47 ohm) can also be added in series with data lines to limit the peak current during a voltage excursion.

Warning: It is the Integrator's responsibility to protect the Enabler module from electrical disturbances and excursions, which exceed the specified operating parameters.

Control Connector Signal Descriptions And Functions

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

The HS 3002 module uses a single voltage source of VCC=+3.4V to 4.4V.

VBAT	Parameter/Conditions	Min	Typ	Max	Units
Main Battery Supply	Voltage In Regulation			4.4	Vdc
Peak Current					mA

Warning: The uplink burst will cause strong ripple on the voltage lines and should be effectively filtered. It is recommended that 1000 to 2000 μF of capacitance be placed as close to the modem I/O connector as possible. It should be noted that the input voltage level should not drop below the minimum voltage rating under any circumstances, especially during the uplink burst period.

Modem Power-on And Recovery Techniques

The HS 3002 provides module integrators with improved modem power-on and recovery techniques, while maintaining backwards compatibility to Enabler IIIG integrations. The addition of an internal power switch and input power-on logic select pin (Pin 85), allows users the flexibility to maintain backwards compatibility or select different power-on options. This internal power switch also allows integrators the flexibility of not supplying an external power switch.

Pin-37, previously a reset pin in the Enabler III module, has been replaced with a device power ON/OFF pin in the HS 3002. This pin controls the internal power switch.

Pin-85 (PSLOGIC) allows users to select the default behavior of the ON/OFF control (Pin-37). Once power is applied via the internal power switch, Pin-35 (PHON) is used like a phone on/off switch.

Power Switch Logic Detect (Pin 85)

This is a hardware input pin to determine the functionality of the ON/OFF pin (Pin-37).

If Pin-85 is tied to VBAT, Modem ON/OFF (Pin-37) defaults to high when the circuit is open, and the internal modem power switch will be ON.

If Pin-85 is left open, Modem ON/OFF (Pin-37) defaults to low when the circuit is open and the modem will be off (requires ON/OFF (Pin 37) to be driven high to power on).

Note: Externally connecting Pin-85 to ground is not recommended

ON/OFF (PIN 37)

Pin-37 is the ON/OFF control input for the modem's internal power switch. When it is high, the modem's internal power switch will be ON. When it is low, the modem internal power switch will be OFF which means the modem is OFF

Note that Pin-35 PHON (Power On) is a signal input and is the normal method for turning the modem ON or OFF. However, Pin 35 cannot turn the modem on if Pin 37 is low, because the modem will not have power applied to it.

Parameter	Parameter/Conditions	MIN	TYP	MAX	UNIT
VIL	Input Voltage – Low or float	TBD	TBD	TBD	Vdc
VIH	Input Voltage – High	TBD	TBD	TBD	Vdc
IPU	Internal Pull-Up Resistor	TBD	TBD	TBD	µA
IIL	Current sink	TBD	TBD	TBD	mA

The modem has an internal power switch that supplies the modem operating power when ON.

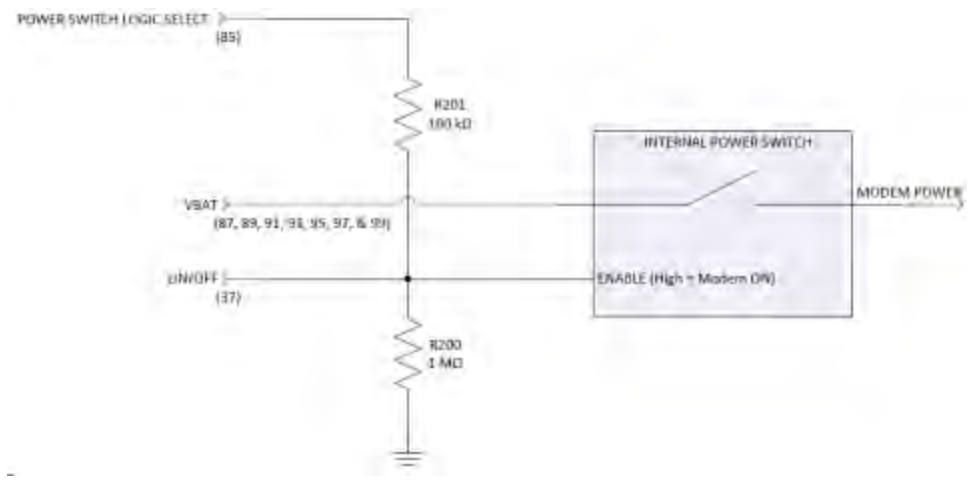


Figure 4-9 Internal Power Switch

The modem may not completely shut down/reset even with a mechanical power switch or this circuit implemented if the modem's I/O lines have another source of power that applies voltage to the modem.
To alleviate this situation, make sure that the interface circuitry is set to tri-state or as an input. If this is not possible, additional hardware may be needed 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 as needed.
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 routinely follow a proper deregistration process. If integrators wish to use this method routinely, then a graceful detach from the network should be accomplished first. This can be done by sending AT$OFF.

Phone On - PHON (PIN 35)

This input signals the modem to start and is equivalent to a "phone power button".

A falling-edge on this Active-Low input will switch-ON the module or switch-OFF the module. This is a firmware controlled OFF function and will deregister the modem from the network before shutting the modem OFF.

This input has a "weak pull-up" resistor internal to the module. If users want the modem to automatically come on when power is applied, they can tie this line low.

If RTC Sleep is required, then the PHON line must be floated to allow the internal resistor to pull the line high. (The RTC sleep function is not available in the initial firmware release.)

Controlling the PHON signal must only be performed by an open collector/open drain device. If controlling this signal from a microprocessor's I/O pin, the PHON can be pulled low when the I/O is configured to be an output and floated high by reconfiguring the pin to be an input.

Warning: The OFF Delay is controlled by the AT$OFFDLY command. A value of 0 disables the PHON line from turning the module off. 0 is the default value. To enable the module to switch-OFF via PHON you must set AT$OFFDLY to a value other than 0. The valid range is 100 to 1000 milliseconds.

Parameter	Parameter/Conditions	MIN	TYP	MAX	UNIT
VIL	Input Voltage – Low or float	TBD	TBD	TBD	Vdc
VIH	Input Voltage – High	TBD	TBD	TBD	Vdc
IPU	Internal Pull-Up Resistor	TBD	TBD	TBD	Ω
IIL	Current sink	TBD	TBD	TBD	mA
ON Pulse Duration		TBD	TBD	TBD	mS
OFF Pulse Duration	Minimum is programmable (AT$OFFDLY)	TBD	TBD	TBD	mS
Boot time	Time to boot from power on to command prompt	TBD	TBD	TBD	Sec

Voltage Reference - VRIO (PIN 77)

To be used 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 uF capacitor at the output. Noise induced on this pin will affect the performance of the baseband. VRIO should be used as the 1.8V reference voltage for voltage translation.

USB (PINS 1, 3, 5, 7)

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
GPIO 1	64
GPIO 2	62
GPIO 3	60
GPIO 4	58
GPIO 5	68
GPIO 6	70
GPIO 7	66
GPIO 8	72

Each general-purpose signal may be selected as inputs or outputs. The GPIOs can be used independently as a user-specified function.

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

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. Refer to the HS 3002 AT command manual for more details.

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

The pin naming for the HS 3002 is referenced from a DTE perspective.The DTE device should match their input pins to the Novatel Wireless M2M pin outs and vice-versa. The modem is considered as DCE. Additionally, there are AT commands that may need to be executed in order to ensure proper operation.

The HS 3002 module is designed to be used like a DCE device.

9-pin D Connector Pin Number	Signal	Signal Direction	Novatel Wireless M2M Pin Number	Novatel Wireless M2M AT Command
1	UART_DCD	from DCE (output from the HS 3002)	19	
2	Receive Data (RD)	from DCE (output from the HS 3002)	15	
3	Transmit Data (TD)	from DTE (input to the HS 3002)	21	
4	UART_DTR	from DTE (input to the HS 3002)	17	
5	Signal Ground			
6	UART_DSR	from DCE (output from the HS 3002)	25	
7	Request To Send (RTS)	from DTE (input to the HS 3002)	11	AT+IFC
8	Clear To Send (CTS)	from DCE (output from the HS 3002)	13	AT+IFC
9	UART_RING	from DCE (output from the HS 3002)	23	

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

- 16C750 compatibility
- Baud rates: 300,600,1200,2400,4800,9600,19200,38400,57600,115200,230400
- Supported data format:
  - Data bit: 8 bits
  - Parity bit: none
  - Stop bit: 1 bit
- Hardware flow control RTS/CTS

Default settings are:

- 8 data
- 1 stop
- no parity
- 115200 Baud.

RTS and CTS may be used for hardware handshaking. 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.
- 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.

Notes:

Tying RTS (pin 11) to ground to “spoof” flow control will cause the modem to draw more current.

It is not recommended to leave RTS (pin 11) unconnected.

Digital Audio Interface (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 its operation and the interface specification:

Digital Audio Configuration

The default settings for the digital audio are:

- Mode = Master
- PCM_CLK = 2.048MHz
- Word Size = 16 Bits
- Sync Pulse = 8KHz
- Frame mode = burst
- Clock edge Sync = rising edge

The following AT command is required to set the unit up in digital audio mode:

```
AT$voicepth=2
```

This configures the HS 3002 module to use digital audio instead of analog audio.

Digital Audio Data Format

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
PCM_DIN	12	Input	Serial Data Input
PCM_DOUT	18	Output	Serial Data Output
PCM_CLK	14	Input/Output	Serial Clock I/O
PCM_SYNC	16	Input/Output	Frame Synchronization I/O

32 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.

Analog-to-Digital Inputs (PIN 44 And 74)

The Monitoring ADC (MADC) consists of a successive approximation 12–bit analog–to–digital converter (ADC).

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

Handset Microphone Input (PINS 65, 67)

Parameter	Test Conditions	Min	Typ	Max	Units	Notes
Full scale input voltage	voltage across either MIC 1P and MIC1N, MIC2P and MIC2N	0.89	1.00	1.12	Vrms	± 1dB level error
Input impendence	Difference input impedance	16	20	24	kΩ	
Input impendence	Single ended input impedance	8	10	12	kΩ	
Input offset voltage		5		5	mV	
Input capacitance	At each pin of all inputs			5	pF	

Handset Microphone BIAS Output (PIN 63)

Parameter	Comments	Min	Typ	Max	Units
MIC bias output voltage			1.8		V
MIC bias output current				1.5	mA
MIC bias voltage accuracy	Minimum load	-3		+3	%
MIC bias output voltage load regulation				30	Ω

Handset Speaker Output (PINS 71, 73)

Parameter	Test Conditions	Min	Typ	Max	Units	Notes
DAC to EAROP/EARON full-scale output	f = 1.02 Hz, 0 dBm	1.11	1.25	1.40	Vrms	± 1 dB level error
EAROP/EARON output power, 4% or less THD+N	f = 498 Hz, 0 dBm	38.5	48.8	61.3	mW	22 to 20 kHz measurement BW
Output DC level, EAR1OP and EAR1ON with respect to VSS	Input = .999 dBm	1.03	1.05	1.07	V	

Headset Microphone Input (PIN 55)

Parameter	Test Conditions	Min	Typ	Max	Units	Notes
Full scale input voltage	voltage across pin 55 and ground	0.89	1.00	1.12	Vrms	± 1dB level error
Input impendence	Single ended input impedance	8	10	12	kΩ	
Input offset voltage		5		5	mV	
Input capacitance	At each pin of all inputs			5	pF	

Headset Speaker Output Left And Right (PINS 57, 59)

Parameter	Test Conditions	Min	Typ	Max	Units	Notes
Both modes - HPH_LP and HPH_RN configured single ended, analog volume control = 0 dB						
DAC to HPH_LP and HPH_RN fullscale output	f = 1.02 kHz, 0 dBm	0.531	0.595	0.668	Vrms	
Output DC level, HPH_LP and HRH_RN wih respect to VSS	Input = 0.999 dBm	1.03	1.05	1.07	V	
Output impedence				0.5	Ω	
Voice Mode - HPH_LP and / or HPH_RN configured single ended, analog volume control = 0 dB						
HPH_LP and HPH_RN output power, 4% or less THD+N	f = 1.02 kHz, 0 dBm	17.6	22.1	27.9	mW	22 to 20 kHz meas-urement bandwidth
DAC to HPH_LP and HPH_RN output noise level	Input = 0.999 dBm, Fs = 8 kHz or 16 kHz, A-weighted			106	µVrms	
Both modes - HPH_LP and HPH_RN configured differential (HPH_LP/HPH_RN), analog volume control = 0 dB						
DAC to HPH_LP and HPH_RN fullscale output	f = 1.02 kHz, 0 dBFS, 32 Ω load	1.06	1.19	1.34	Vrms	
DAC to HPH_LP/HPH_RN gain error relative to gain @ -3 dBFS	f = 1.02 kHz, -60 dBFS	-1.2		1.2	dB	Linearty spot check
Output DC level, HPH_P and HPH_N with respect to VSS	Input = .999 dBFs	1.03	1.05	1.07	V	
Output impedence				1.0	Ω	
Voice Mode - HPH_LP and / or HPH_RN configured differential (HPH_LP/HPH_RN), analog volume control = 0 dB						
HPH_LP/HPH_RN output power, 4% or less THD+N	f = 498 Hz, -3 dBFS, 32 Ω	17.6	22.1	27.9	mW	22 to 20 kHz meas-urement bandwidth
DAC to HPH_LP/HPH_RN out-put noise level	Input = 0.999 dBFS, Fs = 8 kHz, A-weighted			212	µVrms	22 to 20 kHz meas-urement bandwidth

Headeset Detect (PIN 47)

The headset detect signal is an active low signal. The signal is low when a headset is inserted.

Universal Subscriber Identity Module (USIM/SIM) Carrier (PINS 76, 78, 80, 82, 84)

The USIM/SIM, an integral part of any UMTS/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 UMTS/GSM service provider, and has encryption data embedded in it. The USIM/SIM consists of a microprocessor and memory installed on a plastic card.

Note: The USIM/SIM is not provided with the HS 3002 module. The USIM must be obtained from the UMTS/GSM service provider and must be provisioned by the operator for data and/or voice. Always take care to protect the USIM: the UMTS/GSM terminal will not operate without the USIM installed.

The USIM/SIM provides the IMSI for authentication. To gain access to the UMTS/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 USIM 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 by the end user.

USIM/SIM Integration For HS 3002

The HS 3002 module has a Micro USIM/SIM onboard the module as standard. However, a remote USIM/SIM can still be used if desired.

Only the Remote USIM/SIM will be discussed in this integration guide as the onboard Micro USIM is already an integral part of the HS 3002 module.

Using Remote USIM/SIM With HS 3002 (PINS 76, 78, 80, 82, 84)

The HS 3002 module supports the use of 1.8 V and 3 V USIM cards. The module includes a hardware interface module dedicated to Universal Subscriber Identity Module (USIM/SIM). All baud-rates defined in ISO 7816-3 standard are supported for high-speed transmission.

If the module is going to be integrated using a remote USIM/SIM, the following guidelines are provided:

- To utilize a remote USIM/SIM, the integrator must provide a suitable USIM/SIM connector.
- The maximum distance from the module to the remote USIM/SIM connector must not exceed 25.4 cm (10 inches).
- It is recommended to have Zero resistance between the USIM/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

Any compatible USIM/SIM carrier can be used in conjunction with the HS 3002 module. For example:

Suyin P/N: 254021MA006S162ZL

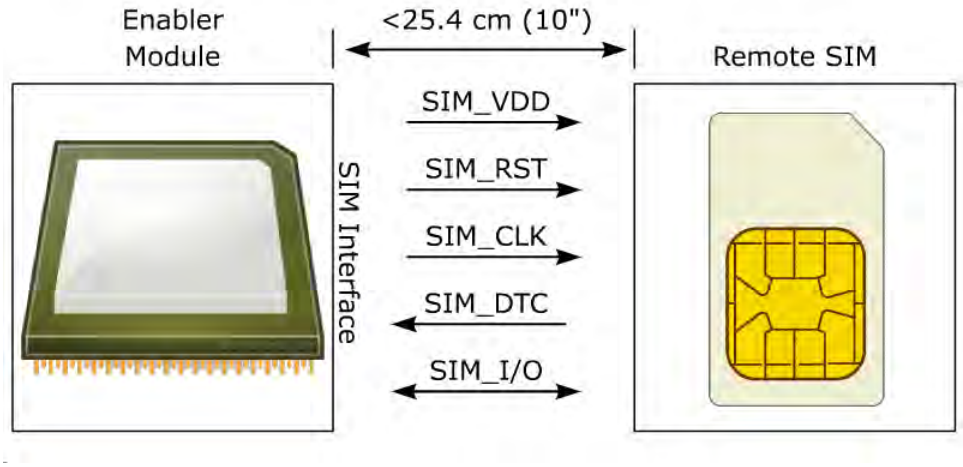


Figure 4-10 Remote USIM/SIM Interface

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
SIM_DTC	84	I	Card detect

The HS 3002 module provides the regulated supply voltage for the USIM/SIM-card and the circuitry to detect the insertion or extraction of the USIM/SIM-card.

The SIMDTC is disabled by default (see AT$SIMDTC in the HS 3002 AT Command Manual for settings). When enabled, the SIMDTC pin has an internal pull up to VCC and can be configured to detect a USIM/SIM insertion when the SIMDTC is either pulled to ground or left floating.

It can be configured to detect either just a USIM/SIM removal or both removal and insertion. USIM/SIM detection is also dependent on the setting of the AT$AREG and AT+CFUN commands (see AT$SIMDTC in the HS 3002 AT Command Manual for more information).

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

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

USIM/SIM	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 USIM/SIM Component Information

Remote USIM/SIM Schematic Example

ESD protection is required for all USIM/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 USIM/SIM connector as possible. The value of the required

capacitor will vary by design, and will typically be below 0.1uF. The USIM/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.

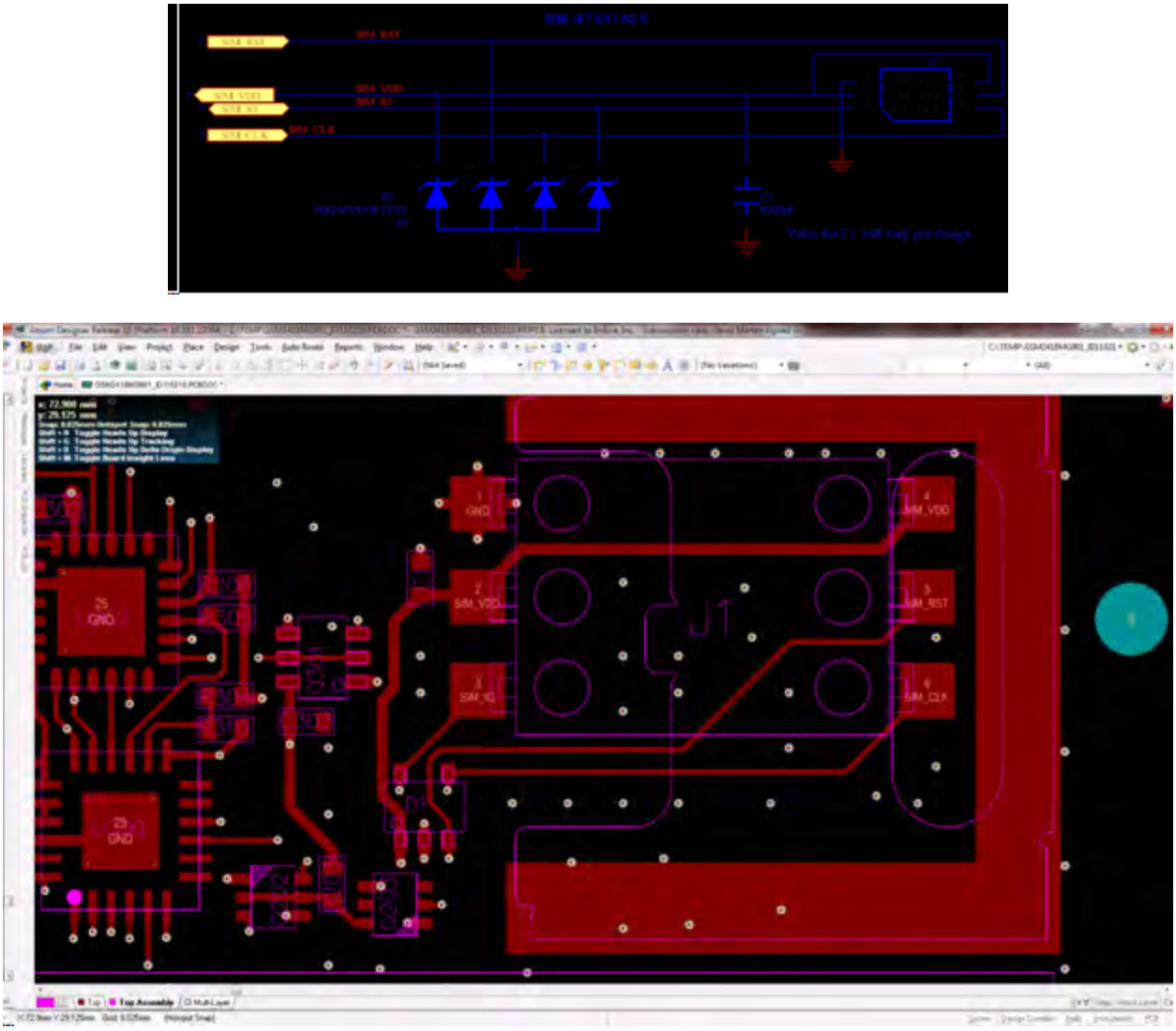


Figure 4-11 Remote SIM Schematic Example

Circuit Protection

Other than very low level ESD protection within the module's integrated circuits, the module does not have any protection against ESD events or other excursions that exceed the specified operating parameters. Only the USB port has onboard ESD/transient protection. We do not recommend using additional external transient protection for this port as it will cause too much capacitance on the lines.

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

Series resistors (typically 47 ohms) can also be added in series with data lines to limit the peak current during a voltage excursion.

It is the Integrator's responsibility to protect the module from electrical disturbances and excursions, which exceed the specified operating parameters.

5

GSM/UMTS Modes Of Operation

Enabling The Transmission Modes For GSM/UMTS Services

Voice Communication

Short Message Service (SMS)

GPRS Data

HSDPA

The GSM and UMTS supports many services and modes. The HS3002 modules supports the following GSM/UMTS services:

- Voice communication
- Short Message Services (SMS)
- Class B GPRS Functionality
- Class 12 EDGE functionality
- HSDPA functionality
- UMTS data functionality

Enabling The Transmission Modes For GSM/UMTS Services

Each of the GSM/UMTS 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, making a data call and 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/UMTS operator to ensure that the services and modes have been provisioned for the SIM

Voice Communication

The HS3002 module has GSM and UMTS voice capabilities, provided the necessary connections have been made for the speaker and microphone pins on the 100-pin I/O connector. The HS3002 AT Command Set Reference - GSM0308AT001 has the entire list of audio commands that can be used to control the voice functionality.

Short Message Service (SMS)

Short Message Services (SMS) is a feature-rich GSM & UMTS service. The HS3002 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)
- 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)

GPRS Data

The HS3002 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
- Multislot 10 Class of Service

HSDPA

TBA

6

Software Interfaces

AT Command Format

Novatel Wireless M2M AT Commands

Novatel Wireless M2M Packet API

The application sends commands to the HS 3002 module via the 100-pin I/O signal connector. These commands use the Novatel Wireless M2M AT Command Set and/or Novatel Wireless M2M's Packet API.

The HS 3002 module operates in one of the following modes:

Command mode: Used for configuring the HS 3002 module, for interrogating the UMTS/GSM network, and for placing and receiving calls. It uses the AT command set via the serial port for communication.

On-line mode: Used after data call has been established. Data is passed between the HS 3002 module and the controlling application without command interpretation. The only AT command that is interpreted in On-line mode is the +++ command. (The +++ command places the HS 3002 module in Command mode but does not terminate the data call.)

IP Packet /API Mode: Used to read/write modem parameters, interrogate network information, and place and receive calls in real-time, multi-tasking mode. The Packet API mode is facilitated over a PPP connection and the packets can be constructed according to the information provided in the Novatel Wireless M2M GSM-GPRS Family API Reference GSM0308UG001.

The AT command driver of the HS 3002 module never exits the Command state, that is, it never enters the On-line mode. Although the host interface may not be able to access the AT command interpreter, it is always running and is available via the API Mode over a PPP connection and/or via the RF interface.

In the Command state, characters that are received from the Customer Premise Equipment (CPE) are treated as AT commands by the HS 3002.

In response to the commands received from the CPE, the HS 3002 module sends characters (AT commands) to the CPE.

Various events can also trigger the HS 3002 module to send characters (AT commands) to the CPE.

AT Command Format

The general format of the command line is: <prefix> <command> <CR>

<prefix>	AT
<command>	See AT Command Manual
<CR>	0x0D

The prefix AT obtains synchronization, identifies the character parameters, and indicates that a command may be in the following characters.

AT commands are not case sensitive: use either capital letters or lower-case letters for the AT command.

Note: Some AT Command parameter values ARE case sensitive and are documented in the HS 3002 AT Command Set.

Novatel Wireless M2M AT Commands

For a full description of the AT commands, refer to the HS 3002 AT Command Set.

Note: A command description that includes an *asterisk denotes that the UMTS/GSM service provider must enable supplementary services functionality before the command is available.

Novatel Wireless M2M Packet API

API Architecture

For description and overview of the Novatel Wireless M2M UDP and TCP-based API architecture please refer to the GSM0308UG001 - Novatel Wireless M2M GSM-GPRS Family - API Reference.

7

USB Driver Installation

USB Driver Installation (Windows XP)
USB Driver Installation (Windows 7)

USB Driver Installation (Windows XP)

These instructions illustrate how to correctly install the USB drivers in Windows XP using the Novatel Wireless M2M Driver Setup Utility.

1. Run the Novatel Wireless M2M Driver Setup Utility by double-clicking the **Novatel Wireless M2MDriverSetup** executable file.

The Novatel Wireless M2M Driver Setup Utility Extraction window opens.

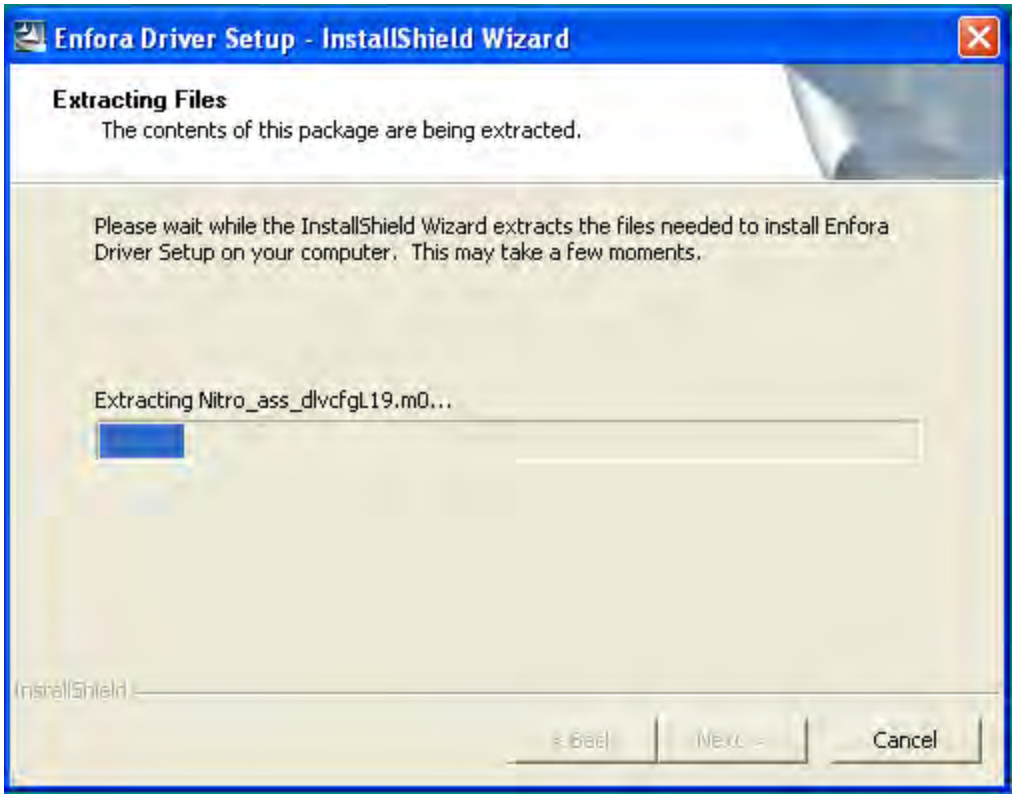


Figure 7-1 Novatel Wireless M2M Driver Setup Utility Extraction

Once the contents have been extracted to memory, the Welcome Window opens.

Figure 7-2 Novatel Wireless M2M Driver Setup Utility Welcome

2. To install the drivers, select **Install**.

   The Novatel Wireless M2M Driver Setup Utility Window opens.

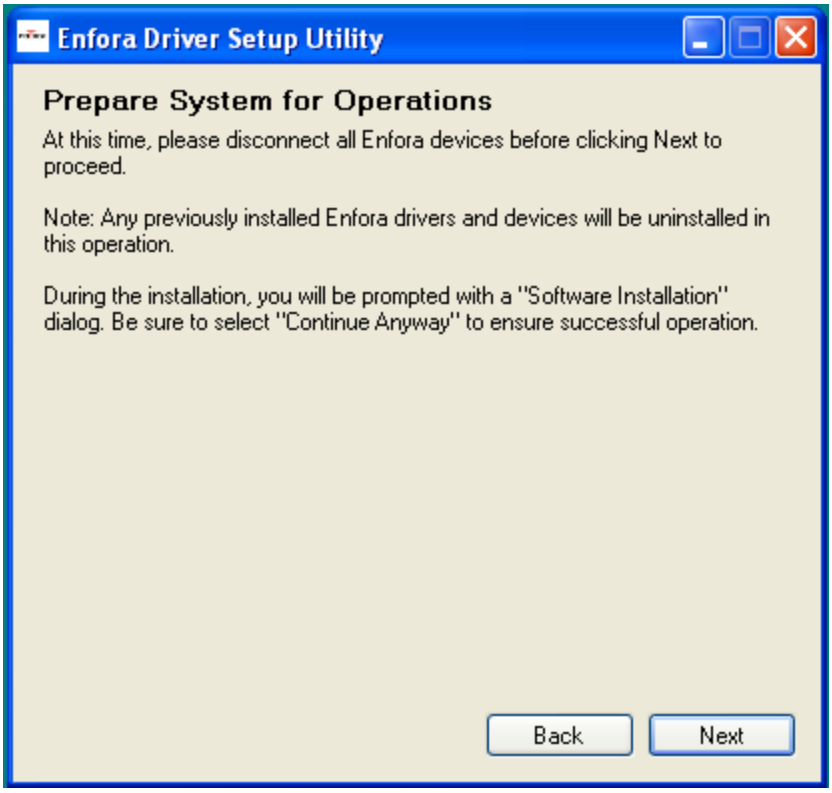


Figure 7-3 Novatel Wireless M2M Driver Setup Utility Prepare System Window

3. Select **Next** to continue.

   The Novatel Wireless M2M Driver Setup Utility Installation Window opens while the system installs the drivers.

4. Disconnect any Novatel Wireless M2M devices.

   Previous drivers will be removed during this phase.

During the installation, your computer's display may freeze and appear non-responsive. If this occurs, allow the computer to continue working. After 2-3 minutes, the display and installer will resume normal behavior.

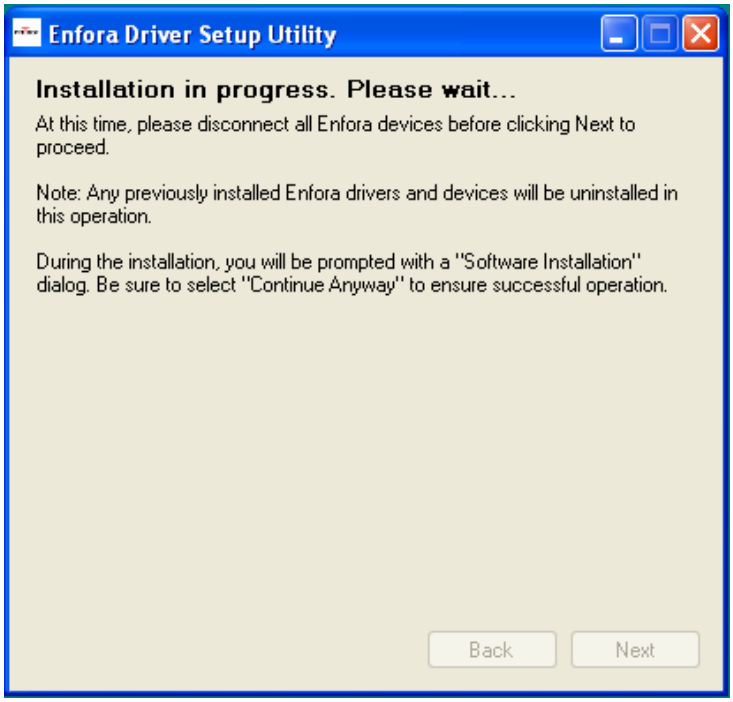


Figure 7-4 Novatel Wireless M2M Driver Setup Utility Installation Window

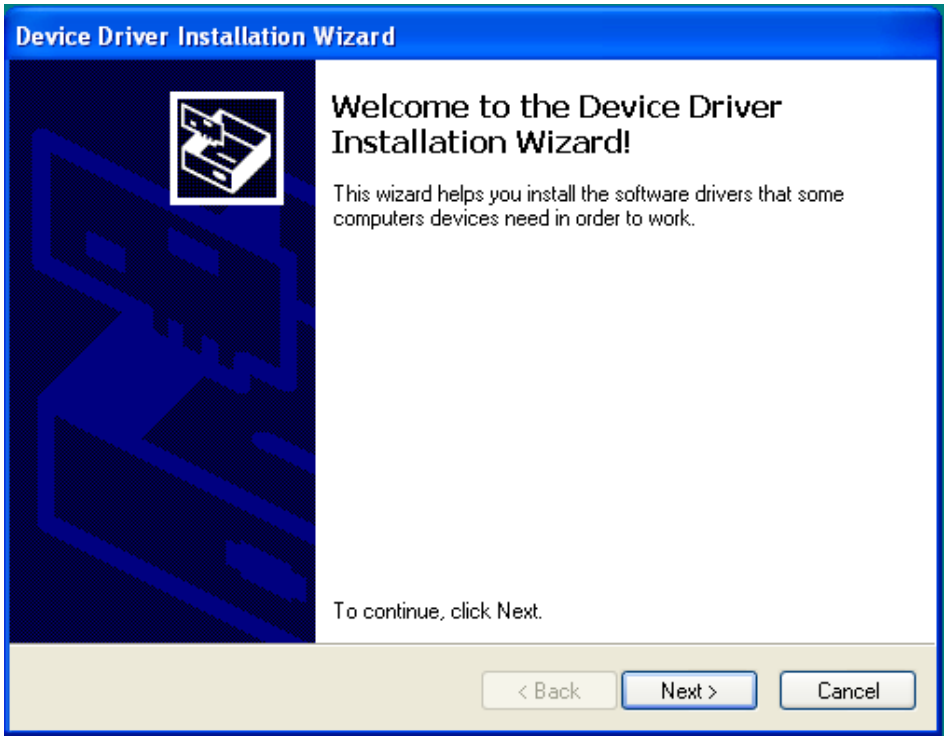


Figure 7-5 Novatel Wireless M2M Driver Setup Utility Driver Installation

5. When prompted to install the device driver, select **Next**.

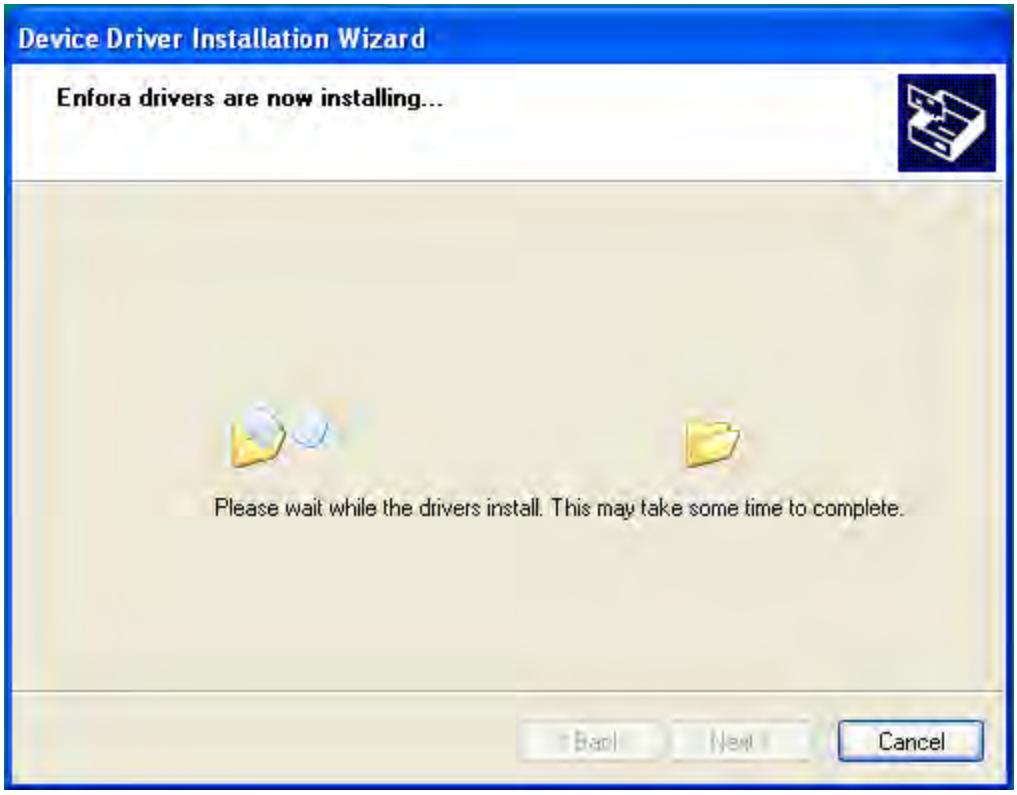


Figure 7-6 Novatel Wireless M2M Driver Setup Utility Driver Installation Progress

You may see the following warning message:

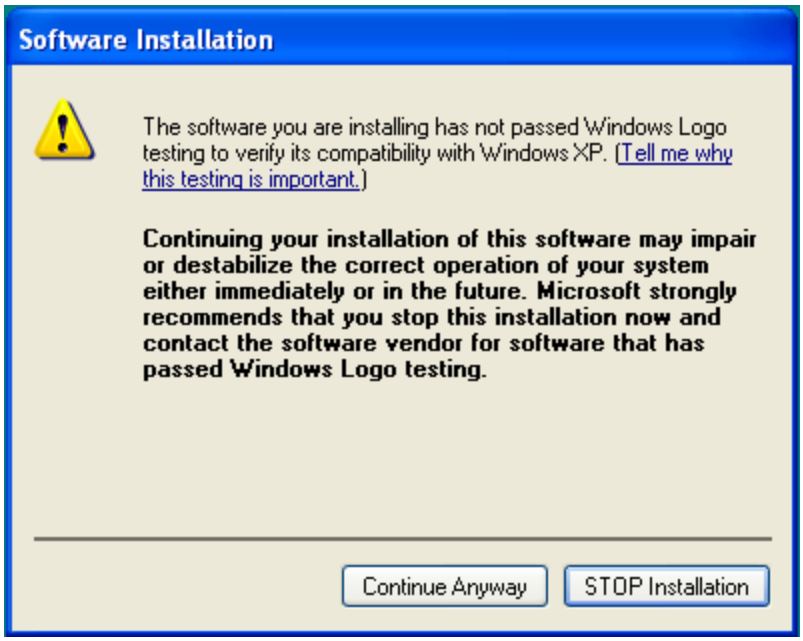


Figure 7-7 Windows Security Window

6. Click **Continue Anyway**.

   When installation of the USB drivers is complete, the Completion window opens.

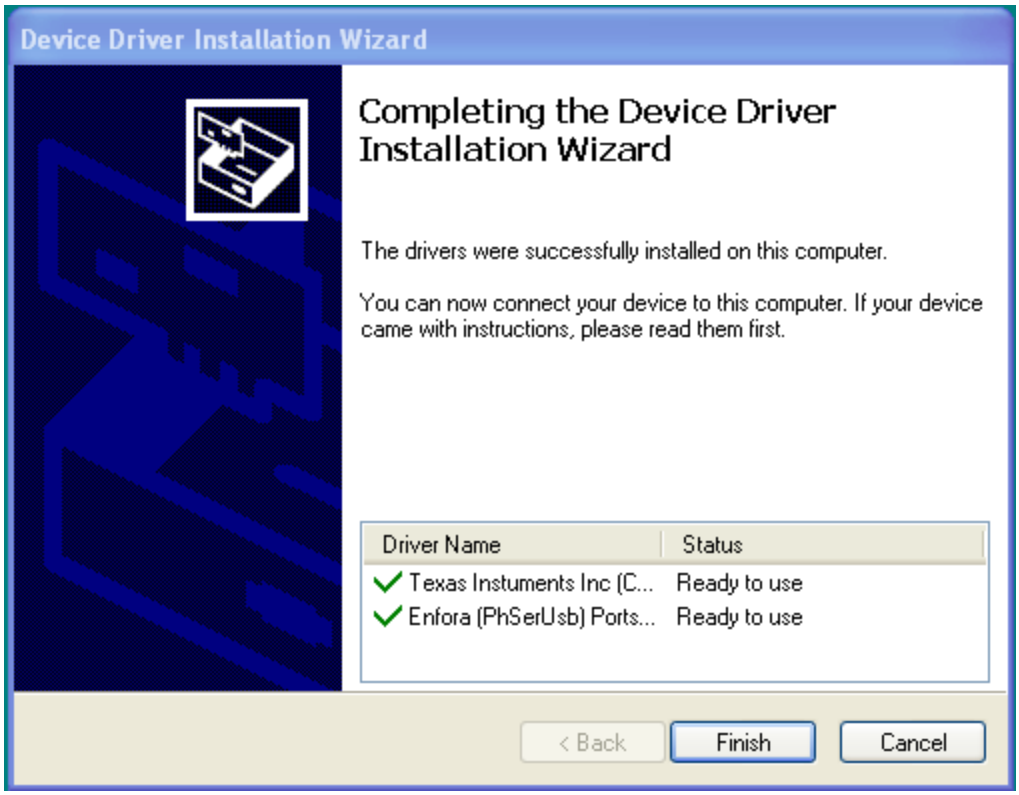


Figure 7-8 Novatel Wireless M2M Driver Setup Utility Driver Install Completion Window

7. Click **Finish**.

   When the installation is complete, the list of attached devices will appear within the Attached Devices Window.

Figure 7-9 Novatel Wireless M2M Driver Setup Utility Attached Devices Window

USB Driver Installation (Windows 7)

These instructions illustrate how to correctly install the USB drivers in Windows 7 using the Novatel Wireless M2M Driver Setup Utility.

1. Run the Novatel Wireless M2M Driver Setup Utility by double-clicking the **Novatel Wireless M2MDriverSetup** executable file.

The Novatel Wireless M2M Driver Setup Utility Welcome window opens.

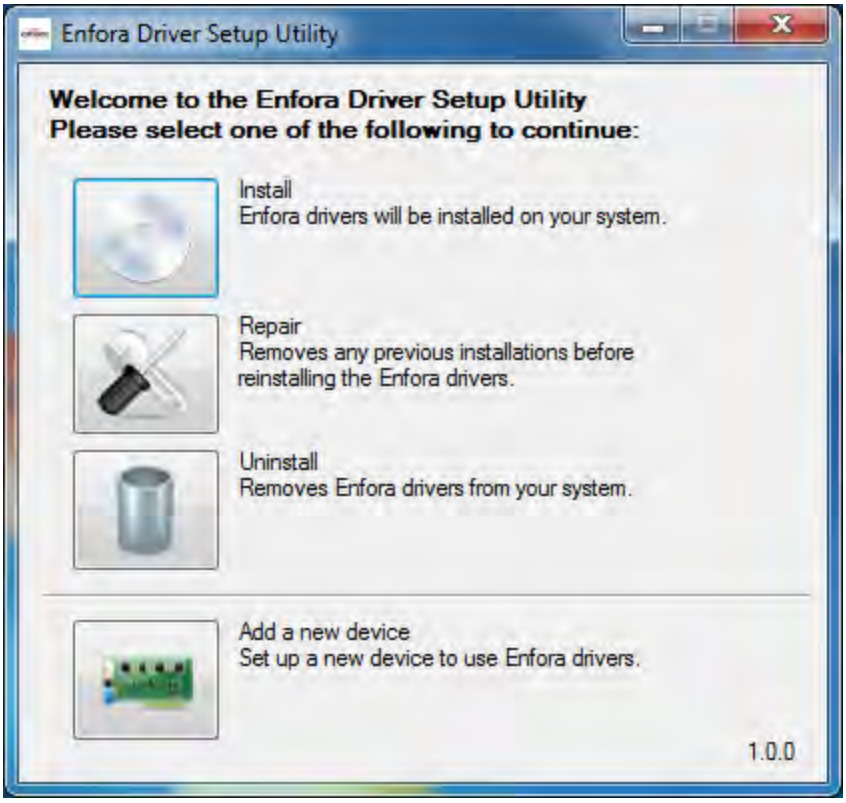


Figure 7-10 Novatel Wireless M2M Driver Setup Utility Welcome Window

Once the contents have been extracted to memory, the Driver Setup Window opens.

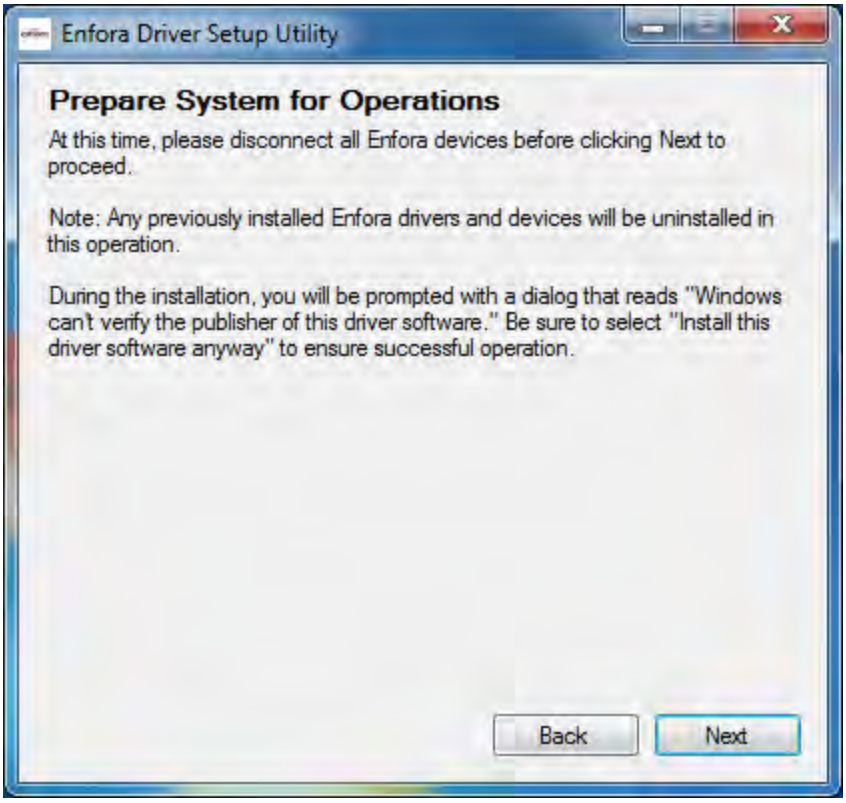


Figure 7-11 Novatel Wireless M2M Driver Setup Utility Preparation Window

2. To install the drivers, click **Install**.

   The Novatel Wireless M2M Driver Setup Utility Prepare System Window opens.

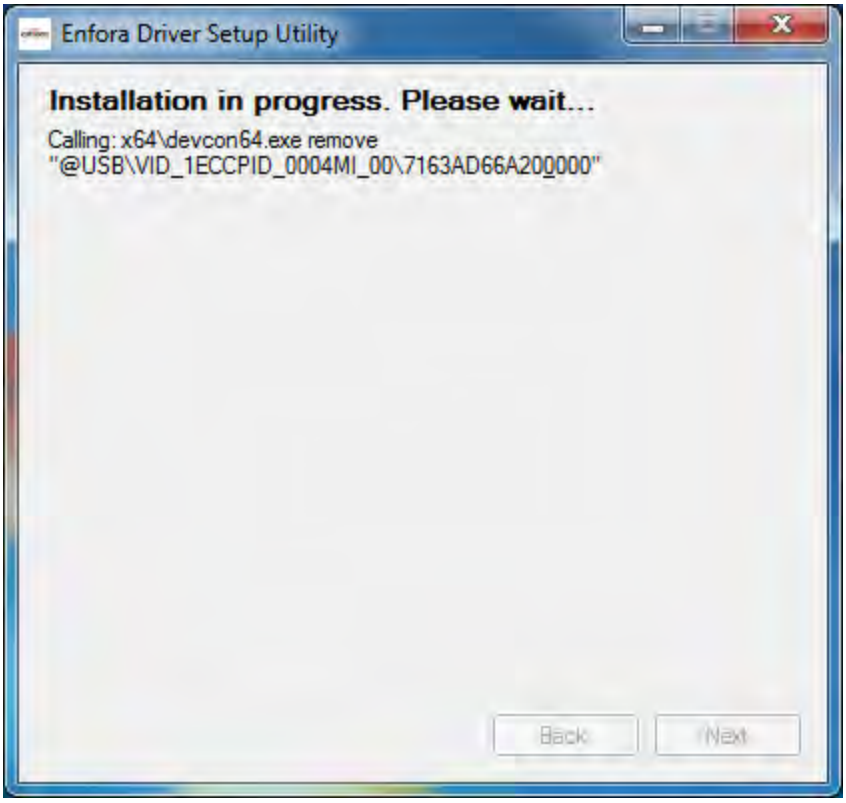


Figure 7-12 Novatel Wireless M2M Driver Setup Utility Installation Window

3. Select **Next** to continue.

   The Novatel Wireless M2M Driver Setup Utility Installation Window opens while the system installs the drivers.

4. Disconnect any Novatel Wireless M2M devices.

   Previous drivers will be removed during this phase.

During the installation, your computer's display may freeze and appear non-responsive. If this occurs, allow the computer to continue working. After 2-3 minutes, the display and installer will resume normal behavior.

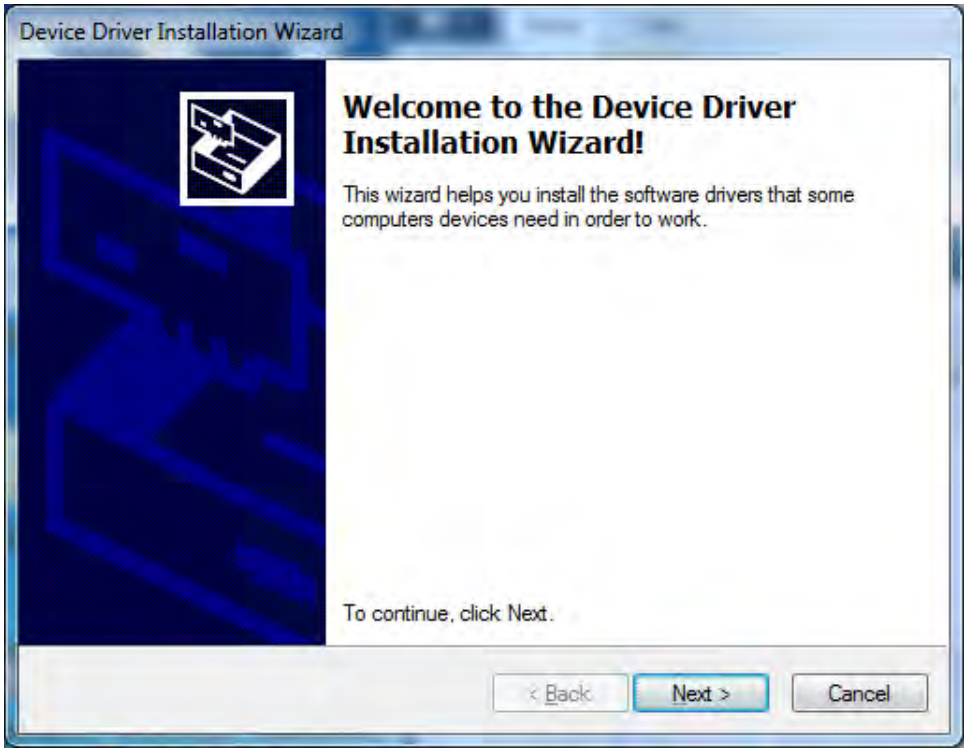


Figure 7-13 Novatel Wireless M2M Driver Setup Utility Driver Installation

5. When prompted to install the device driver, select **Next**.

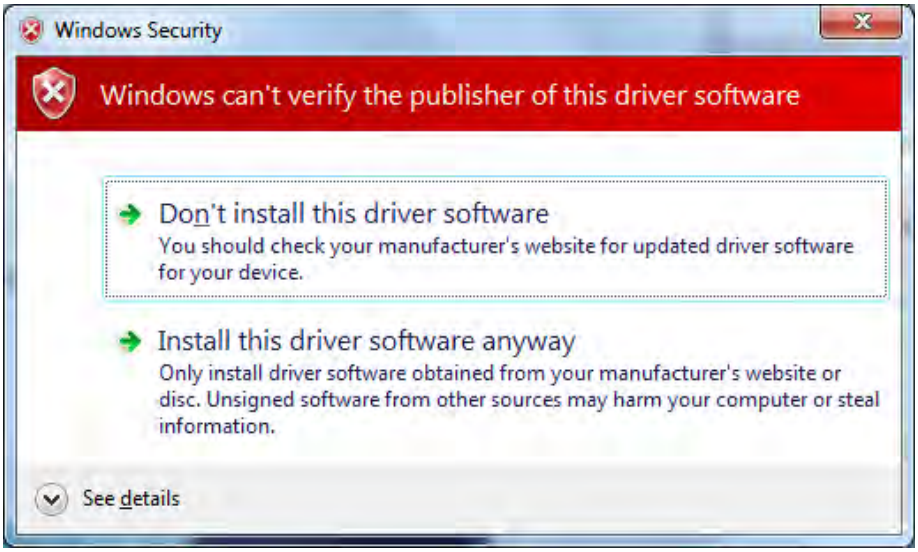


Figure 7-14 Windows Security Window

6. Select **Install this driver software anyway**.

During the driver install phase, you may be prompted to continue or stop installation due to potential compatibility issues.

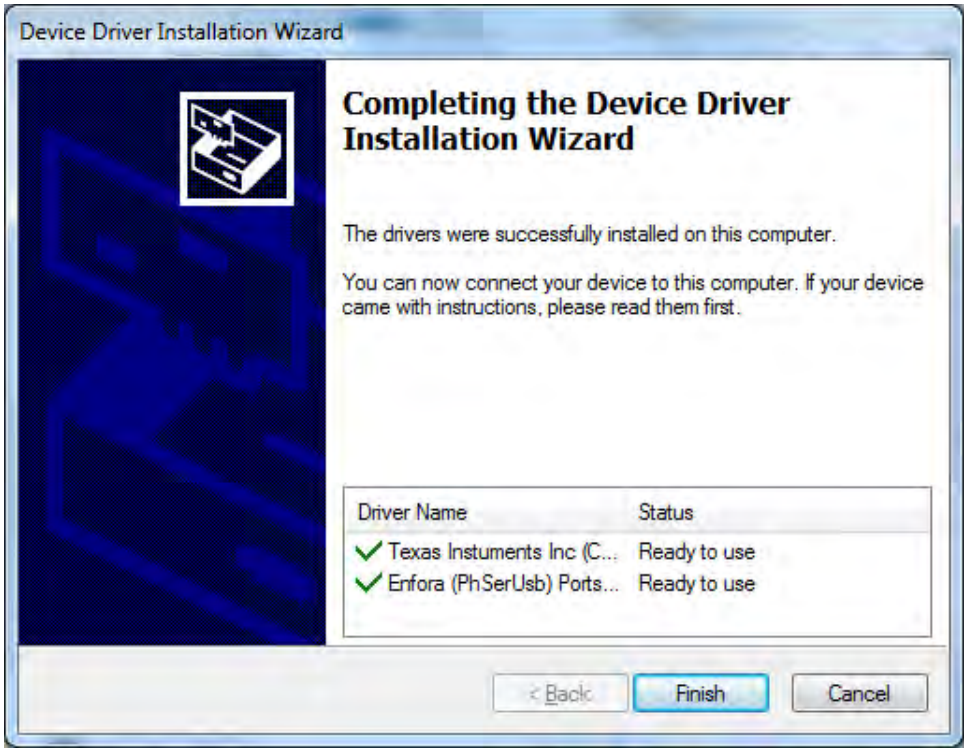


Figure 7-15 Novatel Wireless M2M Driver Setup Utility Driver Install Completion Window

When installation of the USB drivers is complete, the Completion window opens.

7. If there are no errors, click **Finish.**
8. If the status displays an issue, click **Correct issues!**
9. At the "OK to apply fix" prompt, click **Yes**.

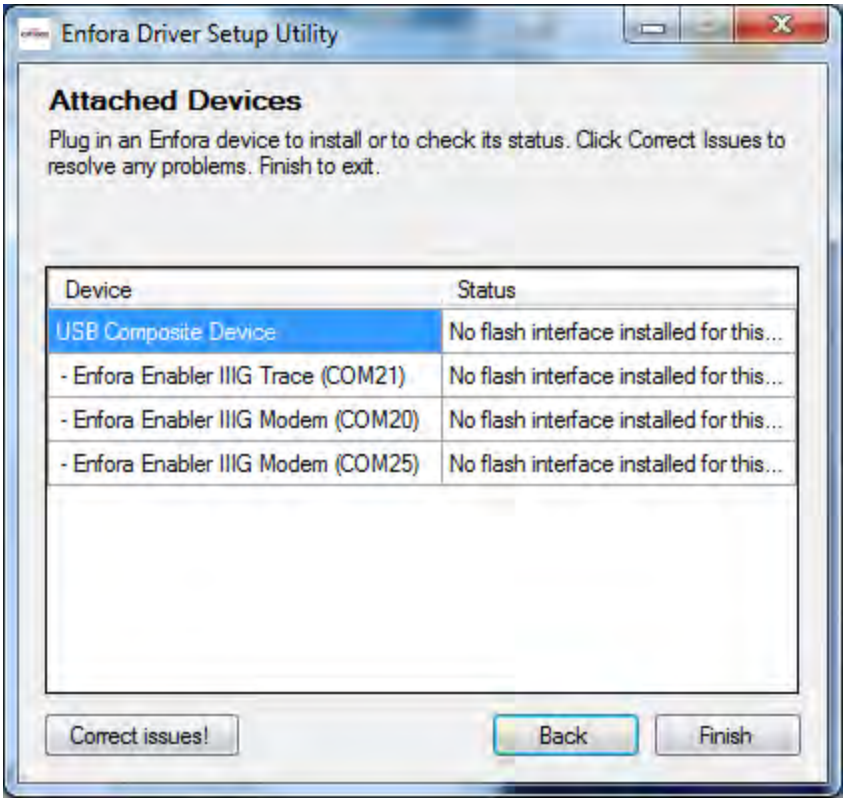


Figure 7-16 Novatel Wireless M2M Driver Setup Utility Attached Devices Window

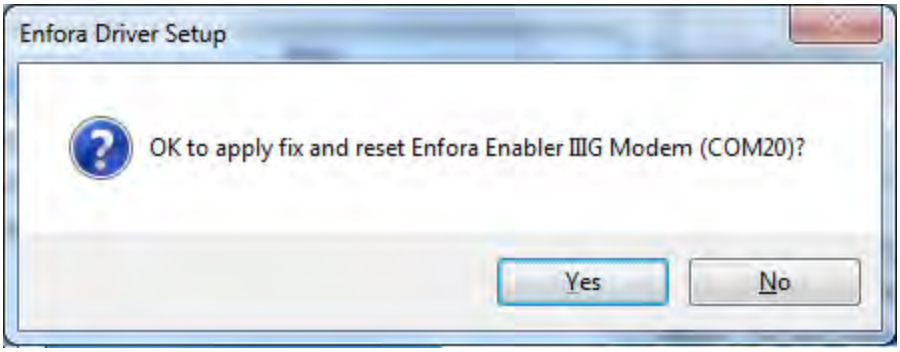


Figure 7-17 Novatel Wireless M2M Driver Setup Utility Apply Fix Window

When the installation is complete, the list of Attached Devices appears within the Novatel Wireless M2M Driver Setup Utility Attached Devices window.

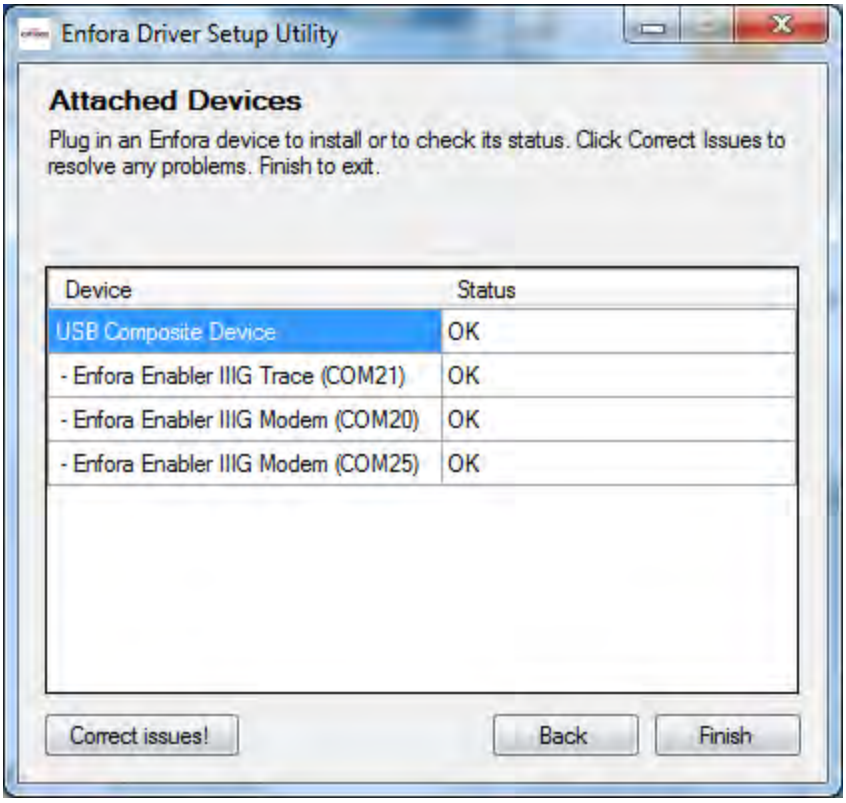


Figure 7-18 Novatel Wireless M2M Driver Setup Utility Attached Devices Window

8

Modem Setup

General Setup
Hyperterminal Configuration for the Module
Initialization (AT Command Interface)
Sending an Initialization String to the Module
Setup the Communication Mode for the Module
Integrating The Module

General Setup

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

Connect the power supply, connect antenna, and install USIM/SIM into modem.

Hyperterminal Configuration For The 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 8-1 Hyper Terminal Definition

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

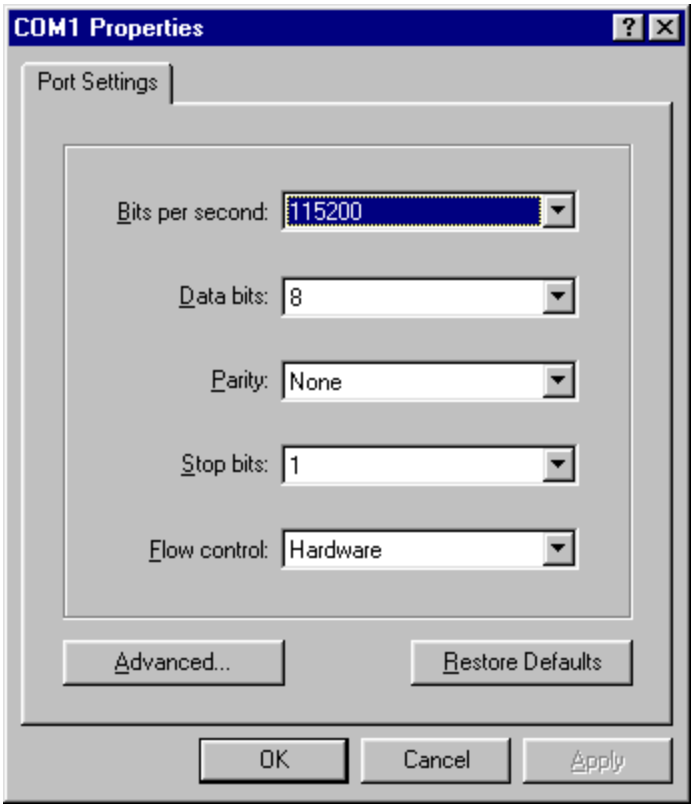


Figure 8-2 COM Port Settings

Initialization (AT Command Interface)

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

Action	AT Command	Description
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 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

Setup The Communication Mode For The 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

The 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 module provides seamless integration into the network.

The integration issues for the application can be narrowed to the utilization of the AT commands and the use of the network 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 Packet capabilities is more complicated than using AT command sequences to initiate the connection and begin transferring data.

Integrating The Module

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/UMTS test equipment (such as Agilent 8960), a computer, and a serial interface tester. The GSM/UMTS test equipment must be able to simulate a GSM and UMTS 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 HS3002 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

Information	Recommendations
SIM	The maximum line length of the SIM interface is 25.4 cm (10 inches). The HS3002 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 serial Interface	The HS3002 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 HS3002 module when tied low.
Audio/Microphone Interface	Preliminary balancing on HS3002 module. Maximum length TBD

Testing the following parameters below verifies the RF parameters that may be affected by such things as;

- RF path loss,
- Power supply noise and
- External interference.

GSM 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	
UMTS Functionality	Parameters to be Tested
Transmitter	TBA
Receiver	TBA

The above table also verifies GSM and UMTS functionality towards proper network communication. In addition, the table below provides functional tests that can be performed for design validation with the live network or GSM/UMTS test equipment.

GSM/UMTS 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	