NOVATEL WIRELESS

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Rev 1
OEM INTEGRATION
GUIDE – E362

Guidelines for System Integration

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ECO	Revision	Date	By	Remark
11449	1	13 September 2011	Daryl Therens	First release

Reference Documents

[1] PCI Express Mini Card Electromechanical Specification, Revision 1.2, October 26, 2007.

[2] PCI Express Card Electromechanical Specification revision 1.1 March 28th 2005

[3]   SMBus Specification, Revision 2.0

[4] The I2C BUS SPECIFICATION Version 2.1 January 2000

[5] TS 36 series specifications on LTE   http://www.3gpp.org/ftp/Specs/html info/36 series.htm

[6] 3GPP TS 01.04: "Abbreviations and acronyms".

[7] 3GPP TS 11.11: "Specification of the Subscriber Identity Module   Mobile Equipment (SIM ME) interface".

[8] 3GPP TS 11.12: "Specification of the 3 Volt Subscriber Identity Module   Mobile Equipment (SIM ME) interface".

[9] 3GPP TS 11.18: "Specification of the 1.8 Volt Subscriber Identity Module   Mobile Equipment (SIM ME) interface".

[10] 3GPP TS 51.010 1 "Mobile Station (MS) conformance specification; Part 1: Conformance specification".

[11] 3GPP TS 23.040: "Technical realization of the Short Message Service (SMS) ".

[12] 3GPP TS 23.041: "Technical realization of the Cell Broadcast Service (CBS)".

[13] 3GPP TS 24.008: "Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3".

[14] 3GPP TS 24.011: "Short Message Service (SMS) support on mobile radio interface".

[15] 3GPP TS 24.012: "Cell Broadcast Service (CBS) support on the mobile radio interface".

[16] 3GPP TS 27.001: "General on Terminal Adaptation Functions (TAF) for Mobile Stations (MS)".

[17] 3GPP TS 27.007: "AT command set for User Equipment (UE)".

[18] 3GPP TS 51.011: "Specification of the Subscriber Identity Module   Mobile Equipment (SIM ME) interface".

[19] ITU T Recommendation V.25ter: "Serial asynchronous automatic dialing and control".

[20] ITU T Recommendation V.24: "List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit terminating equipment (DCE)".

[21]   ITU T Recommendation E.164: "The international public telecommunication numbering plan".

[22]   ITU T Recommendation E.163: "Numbering plan for the international telephone service".

[23] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[24] 3GPP TS 31.102: "Characteristics of the USIM application.

[25] 3GPP TS 23.038: "Alphabets and language specific information".

[26] High Speed USB Platform Design Guidelines, Intel,   Rev. 1.0, dt. 07/12/2000,

[27] 3GPP TS 11.12: "Specification of the 3 Volt Subscriber Identity Module   Mobile Equipment (SIM ME) interface".

[28] 3GPP TS 11.18: "Specification of the 1.8 Volt Subscriber Identity Module   Mobile Equipment (SIM   ME) interface".

[29] 3GPP TS 51.010 1 "Mobile Station (MS) conformance specification; Part 1: Conformance specification".

[30] ISO/IEC 7816 1: "Identification cards – Integrated circuit cards with contacts – Part 1: Physical characteristics".

[31] ISO/IEC 7816 2: "Identification cards – Integrated circuit cards with contacts – Part 2:Dimensions and locations of the contacts.

[32] ISO/IEC 7816 3 "Identification cards – Integrated circuit cards with contacts – Part 3: Electronic signals and transmission protocols".

[33] Compliance Test Plan: LTE over the air Radiated Performance, version 6.0, Verizon Wireless, September 2010.

Notices

Safety Warning

The E362 modem 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 onboard 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 offence.

Under extended operation, the E362 modem will generate a noticeable amount of heat. This modem generates heat during normal operation and will be heated by the host computer. For this reason, it is recommended that after extended periods of operation of this modem, you allow the modem to cool down prior to removal and handling.

1. Overview of LTE Module E362

The E362 modem is part of the Novatel Wireless' Expedite® PCI Express Mini Card family of modules. This module is capable of providing the terminal side interface of an LTE Network. The modem is designed to support the LTE terminal devices to be connected primarily to the *Verizon Wireless Network* in the U.S.A. In addition to LTE, the E362 modem supports 3G and 2G wireless technologies such as HSPA+ / EDGE / GPRS, CDMA EVDO DO Revision 0 and Revision A, and CDMA 1xRTT. The modem has been developed to be integrated into devices such as Notebook PCs, Notebook Tablet PCs, hand held devices, etc., and are based on the PCI Express Mini card specification 1.2 [1].

Following are the bands in which the E362 module is operational for each wireless technology.

Table 1: Supported Technologies and Frequency Bands

System	Band	Band Name	Uplink (MHz)	Downlink (MHz)
CDMA	BC0	Cellular	824 – 849	869 - 894
	BC1	pcs	1850 – 1910	1930 - 1990
GPRS/EDGE	850	Cellular	824 – 849	869 – 894
	900	900	880.0 – 914.8	925.0 – 959.8
	1800	DCS	1710.2 – 1784.8	1805.2 – 1879.8
	1900	PCS	1850 – 1910	1930 – 1990
HSPA+	V	Cellular	824 – 849	869 – 894
	VIII	900	880 – 915	925 – 960
	II	PCS	1850 – 1910	1930 – 1990
	I	IMT	1920 – 1980	2110 – 2170
LTE	XIII	Verizon 700	777 – 787	746 – 756
GPS	L1	GPS	NA	1565.19 – 1585.65
	L1	Glonass		1598.06 – 1605.94

The design of the module is based on the MDM9600 chipset of Qualcomm™. This chipset supports Equalizer and Receive Diversity technologies. The Equalizer technology reduces the inter symbol interference caused by multi paths. The receiver diversity helps to retrieve signals under deep fades caused by multi paths.

The E362 modem is compatible with Microsoft Windows™ compliant applications including VPN, email, and web browsing. The core protocol stack of this modem is supplied by Qualcomm™ and it contains software modules for supporting LTE, UMTS, HSDPA, GPRS/EDGE and CDMA technologies. Around this core, Novatel Wireless has created Firmware Drivers that provide access for the host to the hardware of the embedded modem. Accordingly, the feature set of the modem comprise data device features supported in the Qualcomm™ protocol stack and the features implemented by Novatel Wireless in the Drivers. The list of key features is as follows:

- LTE
- HSDPA/UMTS
- EDGE/GPRS class 12
- Quad band GPRS/EDGE 850/900/1800/1900
- CDMA 1xRTT, EVDO Rev. 0, and Rev. A

- GPS
- SIM/USIM
- MobiLink™ and SDK available for third party dashboards

The hardware of the module consists of a PCI Express Mini Card compliant interface (except for certain customizations required by vendors as described later in this document). The major parts assembled on this card are a baseband chipset and an RF chipset, both of Qualcomm™, together with various other components used in the design of the modem using these major parts.

The purpose of this document is to provide information on the hardware, the firmware and the drivers of the E362 modem. This document also provides information on certain Application Programs which the customers of this modem may or may not make use of. The information available in this document will be helpful to begin the evaluation of the E362 modem, and the subsequent successful integration into host platforms.

2. Module Specification

As was described in the previous Section, the E362 modem has been designed in accordance with the PCI Express Mini Card Specification 1.2 [1]. The governing body for PCI Express standardization is PCI SIG (Peripheral Component Interconnect Special Interest Group).The website for PCI SIG can be found at the following URL: www.pcisig.com/home

The E362 modem provides platform developers and system integrators with the ability to enable 4G/3G/2G wireless broadband access. The modem you have obtained may have undergone certain customization specific to your requirement. These customizations are carried out with respect to certain reserved pins as specified in the PCI Express Mini Card Specification. By using these reserved pins, a user of the customized modem may be able to implement certain functions that are outside the scope of the PCI Express Mini Card specification. In that respect, the specification of the modem module you have obtained might differ from the generic specification of the E362 modem.

The important topics of the specification required for the integration of this modem into host devices are given below:

2.1 Mechanical Specification

The E362 modem meets the form factor as specified by the PCI Express Full Mini Card Electromechanical Specification Revision 1.2 Type F2.
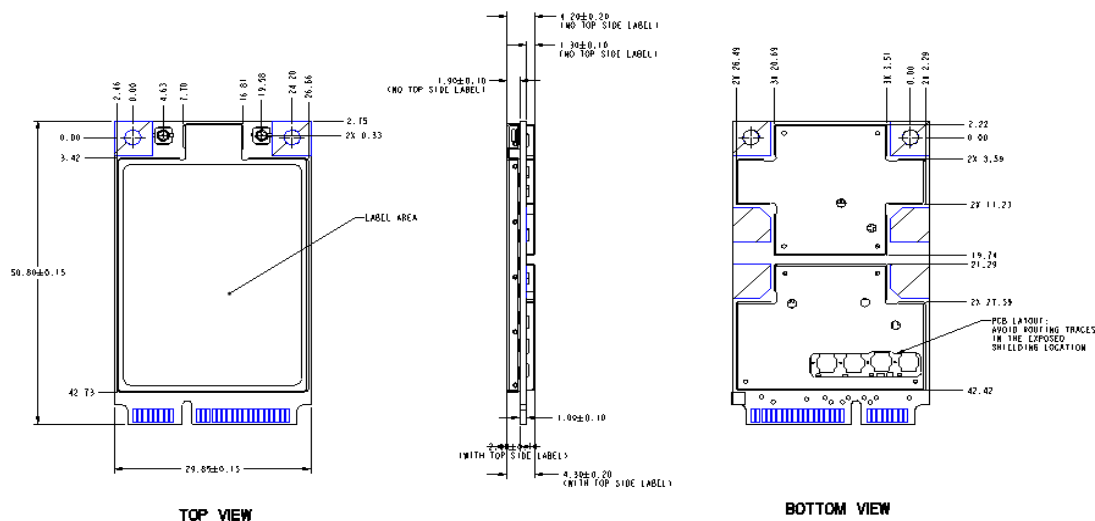
Figure 1: Mechanical Dimensions

Proprietary and Confidential
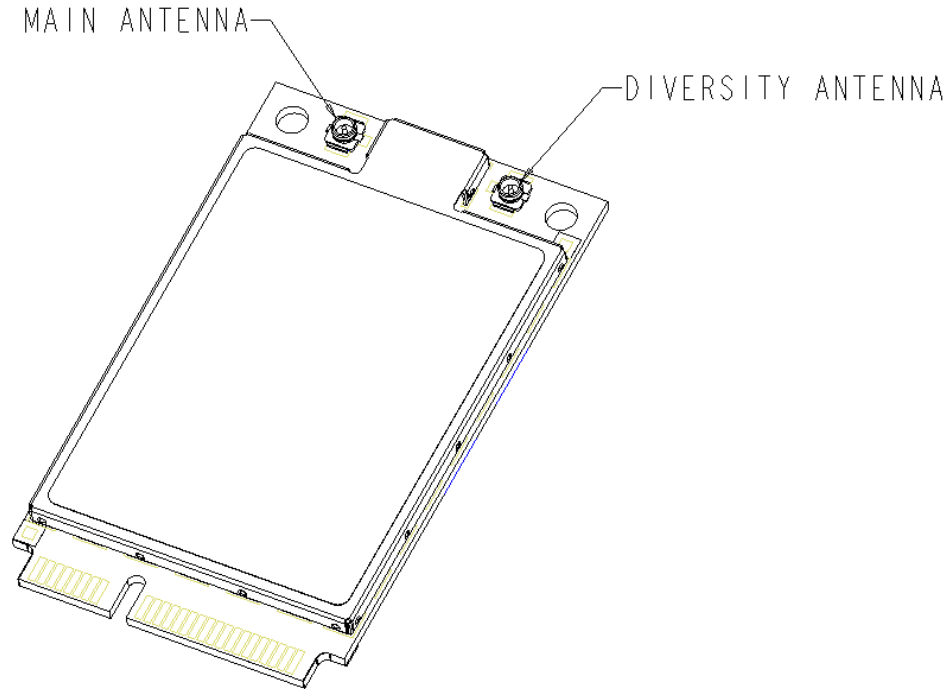
Figure 2: Antenna Connector Locations

Figure 1 indicates the mechanical dimensions and Figure 2 shows antenna connector locations.

2.2 Electrical Specification

2.2.1 PCIe Interface

The Table below gives a description of the pin out and the signal description.

Table 2: PCIe Pinout

Pin#	Function	Pin#	Function
51	No Connect or GPS_DISABLE# (note 1)	52	+3.3Vaux
49	(No Connect)	50	GND
47	(No Connect)	48	(No Connect)
45	(No Connect)	46	(No Connect)
43	GND	44	(No Connect)
41	+3.3Vaux	42	LED_WWAN#
39	+3.3Vaux	40	GND
37	GND	38	USB_D+
35	GND	36	USB_D-
33	(No Connect)	34	GND
31	(No Connect)	32	SMB_DATA or No Connect or GPIO_C1 (note 1)

Pin#	Function	Pin#	Function
29	GND	30	SMB_CLK or No Connect or GPIO_C2 (note 1)
27	GND	28	(No Connect)
25	(No Connect)	26	GND
23	(No Connect)	24	+3.3Vaux
21	GND	22	(No Connect)
19	(No Connect)	20	W_DISABLE#
17	(No Connect)	18	GND
		Mechanical Key	
15	GND	16	(No Connect)
13	(No Connect)	14	UIM_RESET
11	(No Connect)	12	UIM_CLK
9	GND	10	UIM_DATA
7	(No Connect)	8	UIM_PWR
5	(No Connect)	6	(No Connect)
3	(No Connect)	4	GND
1	No Connect or WAKE#	2	+3.3Vaux

Note 1: Contact Novatel Wireless for details.

2.2.2 W_DISABLE# Interface

The Figure below shows the modem pull-up resistor configuration for the W_DISABLE# pin.
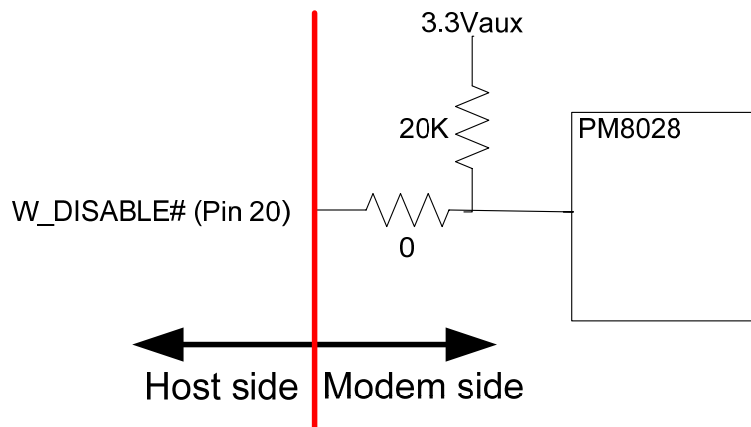
Figure 3: W_DISABLE# Pull-up Configuration

The W_DISABLE# signal from the host interface connector (pin 20) is used to control the operational status of the radio transmitter. When it is high, the radio is capable of transmitting. When it is low, the radio is made incapable of transmitting by removing the various power supplies.

When the host asserts the W_DISABLE# signal low, an interrupt is generated which executes power down routines such as saving any required data. The software programs the power management device (PM8028) to selectively disable voltage regulators in order to render the modem incapable of transmitting.

The assertion and de-assertion of W_DISABLE# is asynchronous to any system clock.

The modem meets the logic signal requirements as defined in Table 3-7 of the PCI Express Mini Card Specification 1.2 [1]. The table below is shown for reference, and lists the 3.3V card logic levels for the W_DISABLE# signal.

Table 3: DC Specification for 3.3V Logic Signaling

Symbol	Parameter	Conditions	Min	Max	Units	Notes
+3.3Vaux	Supply Voltage		3.3 – 9%	3.3 + 9%	V	1
V_{IH}	Input High Voltage		1.95	3.6	V	
V_{IL}	Input Low Voltage		-0.5	0.8	V	
I_{IN}	Input Leakage Current	0V to 3.3V	-10	+10	µA	
I_{LKG}	Output Leakage Current	0V to 3.3V	-50	+50	µA	
C_{IN}	Input Pin Capacitance			7	pF	

NOTES:
1. As measured at the card connector pad.
2. The W_DISABLE# signal is falling edge triggered.
3. The W_DISABLE# signal cannot be driven high if the module is not powered.

2.2.3 WAKE# Interface

The WAKE# signal is an open collector, active low signal. It is used to request that the host system return from a sleep/suspended state to service a function initiated wake event.

If the wakeup process is implemented in the host platform, a host pull-up resistor (≥ 5kΩ recommended) tied to no higher than +3.3Vaux is required on this pin. The Figure below shows the modem configuration.
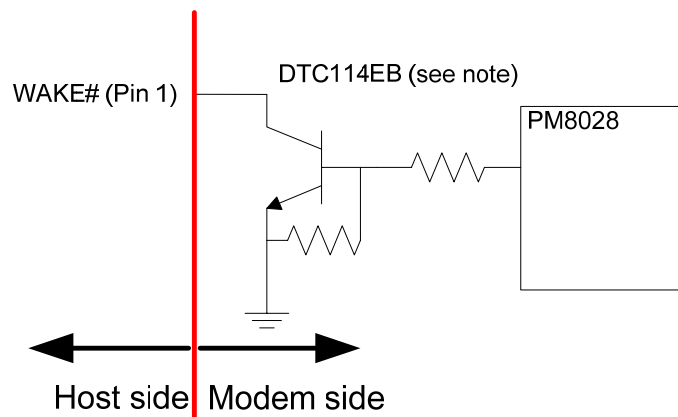
Figure 4: WAKE# Configuration

NOTE to Figure 4: The DTC114EB device may be changed to an equivalent device without prior notice. Contact Novatel Wireless for details.

The assertion and de-assertion of WAKE# is asynchronous to any system clock.

Refer to Table 4 for logic signal requirements for the WAKE# signal.

Table 4: WAKE# Requirements

Symbol	Parameter	Conditions	Min	Max	Units	Notes
V_{OH}	High level output voltage			+3.3V_aux	V	Connects to an open collector transistor inside the E362 device
V_{OL}	Low level output voltage		0	0.5	V	
I_{OL}	Output Low Current for open-drain signals	0.4V	4		mA	
C_{OUT}	Output Pin Capacitance			30	pF	

2.2.4 USB Interface

The device supports USB 2.0 Hi Speed mode.

2.2.5 LED_WWAN#

This pin (titled LED_WWAN_N) is connected to MPP_04 of the PM8028. This is connected to pin 42 of the PCIe connector. The output should be configured to drive from the 3V3 voltage rail. This output is limited to sourcing or sinking +3mA/-3mA. Therefore, it must not directly drive an LED. The modem design by default assumes that this signal drives the gate of a PFET in series with an LED. This signal is active low, and the signal will turn on the LED when a logic state "0" is applied to the pin

2.2.6 Subscriber Identification Module (SIM) Interface

The SIM will be hosted on the host motherboard. A SIM cannot be hosted on the E362 module. A 4 pin SIM interface connector is available on the Mini Card edge connector of the E362 modem. The SIM is also known as Universal SIM (USIM) in 3GPP networks and Removable SIM (RSIM) in 3GPP2 networks. The SIM interface at the edge connector of E362 will support 1.8V USIMs, 3.0V USIMs and 3.0V SIMs. Please see Section 3.2 for guidelines for the integration of the SIM.

Hot-swapping of SIMs is not supported.

2.2.7 Power Supply

The E362 modem is fully operational when the range of the input voltage is 3.3V ± 9%.

2.3 Specification for RF sub system

2.3.1 Antenna Connector

The positions of the antenna connectors of the E362 are indicated in Figure 2. This modem is designed to be connected to an external antenna (integrated into the host system). The antenna ports present nominal 50Ω impedance to the external antenna.

The TX and primary RX connection is present on the main connector.
The Diversity RX and GPS connection is present on the Aux connector.

The antenna connectors are Hirose U.FL R SMT or equivalent. Please note that these connectors are designed for a limited number of insertions and removals (30 cycles, maximum).

2.3.2 Primary and Diversity antennas

The RF performance is heavily dependent on the selection and placement of antennas. The antennas shall be chosen in accordance with the following considerations:

- The antennas shall have a nominal impedance of 50Ω for all the bands they support.

- The return loss shall be ≤ 10 dB throughout the range of all frequency bands of operation.

- The antenna gain may be such that the system shall satisfy the radiation limits for maximum power and regulatory requirements. For example, usually the antenna solution may require a compromise between achieving maximum power and compliance with the SAR requirements.

The module is sufficiently shielded so as to reduce the direct effect of radiation. However, indirect effect may arise if the traces or connector pins are affected by the radiation. The antenna location should be chosen such that the radiation does not affect either the host system or the module.

2.3.3 GPS

GPS is supported by the E362 module. The antenna for receiving the GPS signal is the auxiliary antenna (Please see Figure 2.). The module will support the following GPS features, provided that the associated application and the Network also support the operation of the features identified below.

GPS Features

- GPS Standalone mode (without assistance from the Network).

- GPS MS Based (Mobile Station based) gives fast fix and better sensitivity. Requires periodic support from PDE (Position Determining Entity). in 3GPP Networks, PDE's counterparts are GMLC (Gateway Mobile Location Center) and Serving Mobile Location Center (SMLC),

- GPS MS Assisted best coverage and best accuracy. Requires constant PDE support.

GPS Application Services

- Simultaneous GPS fix and data session. Autonomous GPS with caching of ephemeris and last fix.

- Interfaces

    – Serial NMEA interface pass through MobiLink 3™ or NovaCore API for location request and tracking.
    – SMS Activated Location Responder
    – GPS Timer and Fencepost trigger

- Applications

    – Common GPS/LBS client on host device.
    – Popular Adapters to Browser, Map, Traffic & POI client apps.
    – Vertical Market Subsystem enabler – client tracking & fixing.

    – Possible Location Server / Dispatch Assist.

2.4 Environmental Specification and Compliance

The E362 modem complies with the PCI Express Full Mini Card Revision 1.2 Type F2 standards. The modem will meet the limits indicated in Table 5.

It should be noted that Novatel Wireless cannot guarantee that the host device (Laptop PCs, PDA, Notebook PC etc.) will be able to endure these same environmental conditions. Users are advised to consult the host device specifications and observe any restrictions of use.

The modem will withstand a 75cm drop to a hard surface and still remain functional.

Electrostatic Discharge and Electro Magnetic Interference

The modem does not provide ESD protection at the antenna connectors or edge connectors. It is the responsibility of the host platform to ensure that there will not be any harmful discharges to the modem.

Table 5: E362 Environmental Specification

Parameter	Value of limit
Low Temperature Storage	-40°C
High Temperature Storage	85°C
Low Temperature Operating	-20°C
High Temperature Operating	65°C
Relative Humidity	95% maximum (non-condensing)
Vibration and High Frequency	147m/s^2 (3Grms) peak; 5 to 5000 Hz random
Drop	75 cm

With regards to EMI, the E362 modem meets FCC part 15 for North American markets, and ETSI EN 301489-1 for European markets. When this modem is integrated into a UE, the UE requires approvals of regulatory authorities (FCC for example).

2.5. Regulatory Approval and Compliance

2.5.1 FCC (Federal Communication Commission)

With reference to safety; health, environment and consumer protection, the E362 modem complies, for the applicable band, with the following parts of the Federal Communication Commission's (FCC) Code of Federal Regulations (CFR):

FCC CFR47 Part 2; Frequency Allocations and Radio Treaty Matters; General Rules and Regulations; Radio Frequency Radiation Exposure Evaluation

FCC CFR47 Part 15; Radio Frequency Devices

FCC CFR47 Part 22; Public Mobile Services

FCC CFR47 Part 24; Personal Communications Services

FCC CFR47 Part 27; Miscellaneous Wireless Communications Services

An FCC grant shall be obtained by the UE in order to demonstrate compliance.

2.5.2 Labeling Notice for End Use Products

For any end use product that the Novatel modem is used in, a label containing the following information must be placed visibly on the outside of the product, as applicable.

This device contains FCC ID: PKRNVWE362 and IC: 3229B:E362

2.5.3 CE (Conformance European)

The E362 modem complies with the essential requirements of all of the applicable European laws and directives with respect to safety, health, environment, and consumer protection. This modem conforms to the essential requirements of the R&TTE (Radio and Telecommunications Terminal Equipment) Directive, 1999/5/EC, and has the CE mark affixed. The applicable sections of the following standards have been used to demonstrate compliance to this requirement.

Table 6: R&TTE Requirements

R&TTE Requirement	Discipline	Definition	Applied Standard
Article 3.1(a)	Health	Safety Testing	ICNIRP 1998[1] European Council Rec.1999/519 EC
Article 3.1(a)	Safety		IEC 60950 1[2]
Article 3.1(b)	EMC	EMC testing (unintentional radiators, etc.)	EN 301 489 01[3]
			EN 301 489 07[4]
			EN 301 489 24[5]
Article 3.2	Spectrum	Network Testing (power, frequency stability, etc.)	EN 301 511[6]
			EN 301 908 1[7]

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[1] International Commission on Non Ionizing Radiation Protection
[2] Safety of Information Technology Equipment
[3]Electromagnetic compatibility and Radio Spectrum Matters (ERM) ElectroMagnetic Compatibility (EMC) standard for radio equipment and services
Part 1: Common Technical requirements
[4]Electromagnetic compatibility and Radio Spectrum Matters (ERM) ElectroMagnetic Compatibility (EMC) standard for radio equipment and services
Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
[5] Electromagnetic compatibility and Radio Spectrum Matters (ERM) ElectroMagnetic Compatibility (EMC) standard for radio equipment and services
Part 24: Specific conditions for IMT 2000 CDMA Direct Spread (URTA) for Mobile and portable radio and ancillary equipment.
[6]Global System for Mobile communications (GSM):
Harmonized EN for mobile stations in the GSM 900 and GSM1800 bands covering essential requirements under article 3.2 of the R&TTE directive
[7]Electromagnetic compatibility and Radio Spectrum Matters (ERM) Base Stations (BS) and User Equipment (UE) for IMT 2000 Third Generation cellular networks.

R&TTE Requirement	Discipline	Definition	Applied Standard
			EN 301 908 2[1]

The E362 modem complies with the applicable 3GPP standards for LTE, CDMA, WCDMA/HSDPA and GPRS/EDGE listed in the Table below.

Table 7: 3GPP Requirements

Source	Standard	Title/Description	Document Number
3GPP	WCDMA / HSDPA / GPRS / EDGE	[UMTS] User Equipment (UE) Radio Transmission and Reception (FDD)	TS 25.101
3GPP	LTE	[LTE] Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) Radio Transmission and Reception	TS 36.101
3GPP2	CDMA	Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Mobile Stations	TIA-98-F
3GPP2	CDMA	Recommended Minimum Performance Standards for cdma2000 High Rate Packet Data Access	TIA-866-1
3GPP2	CDMA	Recommended Minimum Performance Standards for cdma2000 High Rate Packet Data Access	TIA-866-A

Apart from the compliance requirements of FCC and CE as described above, there are many carrier specific compliance requirements that the modem needs to satisfy. A summary of these requirements and a brief description of them are given in Appendix A.

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[1] Electromagnetic compatibility and Radio Spectrum Matters (ERM) Base Stations (BS) and User Equipment (UE) for IMT 2000 Third Generation cellular networks.
Part 2: Harmonized EN for IMT 2000,
CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive

3. Guidelines for Module Hardware Integration

3.1 Radiation Related Performance Parameters

3.1.1 Total Radiated Power (TRP)

Good radiated performance is critical to the satisfactory operation of a User Equipment (UE) while transmitting or receiving over a radio channel over the air (OTA). A comprehensive characterization of radiated performance enables the carriers to know as to how well the UEs work within the specific network design constraints. TRP is a performance metric with respect to the radiated power; lower the TRP, lower the range of the UE.

TRP of the E362 modem is the effective level of radiated power emitted by the antenna of the UE while it is in transmit mode of operation. To quantify the performance of the UE as TRP, the radiated power from the antenna is measured over a spherical surface surrounding the UE. The result of the measurement is a spherical radiation pattern of the radiated power or EIRP (Effective Isotropic Radiated Power). To obtain a single figure of merit, the EIRP pattern is integrated over the spherical surface to obtain the TRP. Carriers specify minimum acceptable TRP levels. These levels must be adhered to by the UE vendors to obtain Technical Acceptance by the carrier.

3.1.1.1 Total Radiated Power Estimator

TRP of the modem can generally be estimated by subtracting from the transmitted power at the antenna connector of the modem the expected loss in the cable between the connector and the antenna, and the efficiency of the antenna. A tabulated spreadsheet is indicated in Table 8 to estimate the TRP. In Table 8, the TRP is estimated from the known values of the maximum power available at the antenna connector of the module, cable loss and antenna efficiency. In Table 9, the estimated TRP is compared with the minimum limit required by Verizon Wireless. In this Table, only the requirement of Verizon Wireless has been furnished. The Integrator (the customer of the E362 modem) may tabulate the requirements of all other carriers that the UE should support. For example, if the UE should satisfy the requirements of Carrier #1 and/or Carrier #2, the corresponding values could be furnished in the spreadsheet by the Integrator and the TRP estimated. For example purposes only, the TRP levels for the LTE technology and the EVDO technologies are indicated in these Tables. The Integrator may tabulate the requirements with reference to other technologies such as GSM or GPRS, if required.

In the Table 8, the values in the column Conducted Max Power (dBm) depend on the limit set in the non-volatile RAM (NVRAM) of E362 for the maximum allowable power. To improve the results, the integrator may be able to increase the limit. Usually, the Integrator has knowledge of this limit. If not, the integrator may contact Novatel Wireless for details.

From the typical results in Table 9 it is seen that the radiated power is to be improved by 0.3 dBm in the cellular band, and 0.3 dBm in the PCS band. The Integrator may be able to satisfy the TRP requirement by a combination of approaches. These approaches are reducing the cable loss, increasing the efficiency of antenna, and, if possible, increasing the limit of the maximum power of the modules.

Table 8: Example of Estimated TRP

TRP Calculator for Embedded Module Antenna					
Band		**Conducted Max Power of module (dBm)**	**Cable + Connector Loss (dB)**	**Antenna Efficiency without cable (%)**	**Estimated TRP (dBm)**
LTE Band 13 777-787 MHz. (Tx) 746-756 MHz. (Rx)	LTE 10MHz. BW	23.5	0.85	50	19.64
Cellular 824-849 (Tx) 869-894 (Rx)	EV-DO	24	1.3	50	19.7
PCS 1850-1910 (Tx) 1930-1990 (Rx)	EV-DO	24	1.3	50	19.7
Band I 2100	WCDMA	23	1	50	19.0
Band II 1900	WCDMA	23	1	50	19.0
Band IV 850	WCDMA	23	1	50	19.0
GSM850	GPRS	32	1	50	28.0
	EDGE	27	1	50	23.0
GSM900	GPRS	32	1	50	28.0
	EDGE	27	1	50	23.0
GSM1800	GPRS	29	1	50	25.0
	EDGE	26	1	50	22.0
GSM1900	GPRS	29	1	50	25.0
	EDGE	26	1	50	22.0

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Table 9: Example of Estimated TRP and Carrier Specified Minimum TRP

Carrier-TRP-Limits and Required performance-improvement				
Band	Carrier #1 dBm	Carrier #2 dBm	Minimum limit of TRP stipulated by Verizon Wireless	Required enhancement in TRP-performance (dBm)
LTE Band 13 777-787 MHz. (Tx) 746-756 MHz. (Rx)			18	N/A
Cellular 824-849 (Tx) 869-894 (Rx)			20	**-0.30**
PCS 1850-1910 (Tx) 1930-1990 (Rx)			20	**-0.30**
Band I 2100				
Band II 1900				
Band IV 850				
GSM850				
GSM900				
GSM1800				
GSM1900				

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3.1.2 Total Isotropic Sensitivity (TIS)

To obtain the TIS of the receiver part of the UE, the sensitivity of the UE is measured over a spherical surface surrounding the UE, similar to the measurement carried out for obtaining the TRP. The sensitivity is a performance metric which represents the minimum power level at which the error rate of the receiver is better than a specific limit. Depending on the radio technology, this limit may be specified on Bit Error Rate (BER), Block Error Rate (BLER) or a Frame Error Rate (FER) or throughput reduction. Sensitivity is measured by lowering the transmit power level of the Base Station Simulator until the specified limit is reached. The power level at the antenna connector of the module required to keep the error rate less than the specified limit is the value of sensitivity. In Section 3.1.2 of Reference [33], it has been indicated that the sensitivity is the power level at the antenna connector at which the throughput falls to 95% of the maximum

throughput of the *reference channel*. For details on this reference channel, please see Table 3.1.2.2 of Reference [33]. In this Table, it is indicated that the tests would be conducted for a given number of Resource Blocks. Levels of maximum throughput for these tests are indicated in this Table.

3.1.2.1 TIS (Total Isotropic Sensitivity) Estimator

TIS can generally be estimated by subtracting the losses and the de sense noise from the conducted sensitivity. The losses include cable loss and the loss on account of antenna efficiency. The desense noise is the noise level in the environment around the UE. A basic spreadsheet estimator[1] can be used to estimate the TIS as indicated below in Table 10.

As was described in Section 3.1.1, for example purposes only, we shall consider only the TIS requirement of Verzion Wireless for the LTE technology and the EVDO technology. The estimation of TIS and the required improvement are carried out in Table 10 and in Table 11. In Table 10, TIS is estimated from the known values. In Table 11, the improvement required for meeting the limit stipulated by Verizon is estimated. From the typical results in Table 11, it is seen that the radiated power is to be improved by 0.66 dBm in the LTE band, by 1.51 dBm in the cellular band, and 2.01 dBm in the PCS band. Reducing the loss over the cable and the connector, and increasing the efficiency of the antenna are the approaches to enhance the TIS performance.

Table 10: Example of Estimated TIS

Band	Technology	Conducted Sensitivity Spec	Conducted Sensitivity (dBm)	Cable + Connector Loss (dB)	PC Noise* Rise over Thermal (dB)	Antenna Efficiency without Cable%	Estimated TIS - Noise Free (dBm)
TIS Estimator for Embedded Modules in Jammer Free Environment
LTE Band 13 777-787 MHz. (Tx) 746-756 MHz. (Rx)	LTE 10MHz. BW	-93.3	-97.2	0.85	3	50	**-90.34**
Cellular Band 5 824-849 MHz. (Tx) 869-894 MHz. (Rx)	EV-DO	-104	-108	1	3	50	**-101.0**
PCS Band 3 1850-1910 MHz. (Tx) 1930-1990 MHz. (Rx)	EV-DO	-104	-107.5	1	3	50	**-100.5**
Band I 2100 MHz.	WCDMA	-106.7	-109	1	3	50	**-102.0**
Band II 1900 MHz.	WCDMA	-104.7	-109	1	3	50	**-102.0**
Band IV 850 MHz.	WCDMA	-104.7	-109	1	3	50	**-102.0**
GSM850	GPRS	-99	-108	1	3	50	**-101.0**
GSM900	GPRS	-99	-108	1	3	50	**-101.0**
GSM1800	GPRS	-97	-108	1	3	50	**-101.0**
GSM1900	GPRS	-99	-108	1	3	50	**-101.0**

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[1] **Disclaimer:** This spread sheet is provided with no warranties whatsoever. Novatel disclaims all liability relating to the use of information in this specification. Note that this table is provided for rough estimation purposes only and is intended to provide a first pass guideline for antenna loss planning. It is not to be a substitute for detailed design activity. Additional losses, efficiency considerations and other system affects will modify the actual resulting TIS and as such results will deviate from the TIS calculator shown above. Updates to TIS limits are not controlled in this document.

estimation purposes only and is intended to provide a first pass guideline for antenna loss planning. It is not to be a substitute for detailed design activity. Additional losses, efficiency considerations and other system affects will modify the actual resulting TIS and as such results will deviate from the TRP calculator shown above. All Cingular, Vodafone, Verizon & Sprint TIS requirements are subject to change and as such Novatel makes no claim to accuracy. Updates to TIS limits are not controlled in this document.

Table 11: Example of Estimated TIS and Carrier Specified Minimum TIS

Carrier TIS Limits and Required Performance-enhancement				
Band	Carrier #1 (dBm)	Carrier #2(dBm)	Verizon TIS - requirement (dBm)	Required performance-enhancement (dBm)
LTE Band 13 777-787 MHz. (Tx) 746-756 MHz. (Rx)			-91	**0.66**
Cellular 824-849 (Tx) 869-894 (Rx)			-102.5	**1.51**
PCS 1850-1910 (Tx) 1930-1990 (Rx)			-102.5	**2.01**
Band I 2100				
Band II 1900				
Band IV 850				
GSM850				
GSM900				
GSM1800				
GSM1900				

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3.1.3 Guidelines for Obtaining Good RF Performance of the Module

3.1.3.1 Ground Connections

When connecting the E362 module to the system ground, the following considerations have to be made:

- Prevent noise leakage by establishing a robust ground connection to the module through the host connector.   Use every available grounding pin on the interface if possible.
- Connect to system ground using the two mounting holes at the top of the module with conductive screws.
- Minimize ground noise leakage into the RF.

3.1.3.2 Power Supply Noise Reduction

Typically, a switched mode power supply is used on the host platform for the generation of the voltage on the 3.3V rail of the modem. Ripple on the voltage rail may generate noise in the RF signal. It is recommended that the ripple on the 3.3V rail be no more than 100 mV$_{pp}$ at peak load.

3.1.3.3 Antennas

Isolation: The main and diversity antennas must have a minimum amount of isolation from each other in order to ensure proper operation of the module. If the isolation is not sufficient, the transmit signal will be received by the diversity antenna thereby impairing the receive chain performance. Specifically, when isolation requirements are not met in the LTE band, the 2nd harmonic of the transmit frequency can cause degradation in the GPS receiver path (which resides on the diversity path). Between the main antenna and the diversity antenna, the minimum isolation requirements are as follows:

- LTE: 27dB
- GPS: 30dB
- All other bands: 15dB

VSWR: System must have an antenna VSWR of less than 2:1 in free space. The antenna VSWR should be measured at input U.FL connector on module, so that the antenna together with the U.FL connector should meet this requirement in free space. A VSWR that is greater than the specified ration of 2:1 will result in poor system performance (TRP/TIS degradation). Under stressed conditions (such as when the system antenna is placed in close proximity to a steel desk/wall for example), the VSWR can increase to 4:1. Values of VSWR more than this value can result in FCC violations (spectral emission violations due to harmonics), and cause excessive power consumption by the modem.

Cable: It is recommended that total insertion loss between module and antenna be ≤0.5dB. This requires that module/antenna location be considered during the industrial design phase of the UE so that the shortest possible U.FL interconnect cable can be used. Larger losses will make it difficult to meet carrier TRP/TIS requirements because of the power drop in the cable. Also, longer cable lengths lower the sensitivity. The cable should be routed such that it is away from noise sources such as switched mode power supply units, clock traces, etc.

3.1.3.4 SAR Compliance

SAR (specific absorption rate) testing is required by European and US certification bodies. This is a measure of energy that will be absorbed by organic tissue over a specific period of time. The primary factors that affect the SAR readings are output power, frequency of the radiation, proximity to antenna or antenna counterpoise and duty cycle.

Early in the physical design stage of the UE, the antenna and the mechanical engineering design teams must examine together the design for ensuring that the SAR requirements can be met. Carefully reading and understanding the FCC requirements can help designers to choose the antenna type, the antenna location and the industrial design of the UE to meet the requirements. Placement and the characteristics of the main antenna are the most critical factors affecting SAR performance.

3.1.3.5 Good Thermal Dissipation

At 3.0V, the E362 module can consume up to 1.1A (normal), 2.75A (peak). Some suggestions to dissipate the heat generated are as follows:

- Connect the module to host device's motherboard via two conductive screws,
- If possible, place the module in a location that affords airflow,
- Place a conductive tape between host device's motherboard and the module. On the motherboard, remove the solder mask so that the conductive tape is directly in physical contact with the copper layer of the ground plane. Provide a large number of vias which would conduct the heat from the tape to inner ground planes.

3.1.3.6 Noise Mitigation

Noise mitigation is essential in order to avoid the interference by the electronics on the host motherboard with the RF circuits of the module. This interference can degrade the module's sensitivity and therefore its dynamic range and usability. Section 1 lists the frequency bands where the module's receivers operate.
Every effort should be made to ensure that there is no host induced noise in these frequency bands. Important design considerations to avoid interference include:

- Selection of clock frequencies for the host motherboard for which the fundamental and harmonics fall outside the frequency bands mentioned above. For example: a 196MHz clock would have a 10th harmonic at 1960MHz, which is at the center of the 1900 CDMA/WCDMA/GSM band.. Simply shifting the clock frequency on the host motherboard to 190MHz would avoid any interference.
- Decoupling the RF frequency at the output of power supplies.
- Providing shielding layers around high speed clock traces by using multi-layer PCBs and/or shield cans.
- Routing the antenna cables away from noise sources on the host motherboard.

As shown in the Bottom view of the module indicated in Figure 1, there is a cut-out on the shield of the modem, close to the edge connector. It is recommended that traces on the host motherboard be routed away from this area. The intent is to reduce coupling from any noise that may be radiating from this slot.

3.2 Guidelines for integration of SIM

3.2.1 Description of SIM

The SIM contains information related to subscriber identification, specification and authentication. With reference to the operating voltage, there are two different types of SIMs; one whose reference voltage is 1.8V and the other whose reference voltage is 3.0V. The physical size and contact location for the "Plug in SIM" format is defined in reference [7]. For the SIM connector, the contact identification is defined in reference [8]. Electrical characteristics for a 3V SIM are defined in Reference [8], and for a 1.8V SIM in reference [9]. Power sequencing and general protocol operation are defined in reference [32]. The figure below shows a "Plug in SIM" and its contact locations.
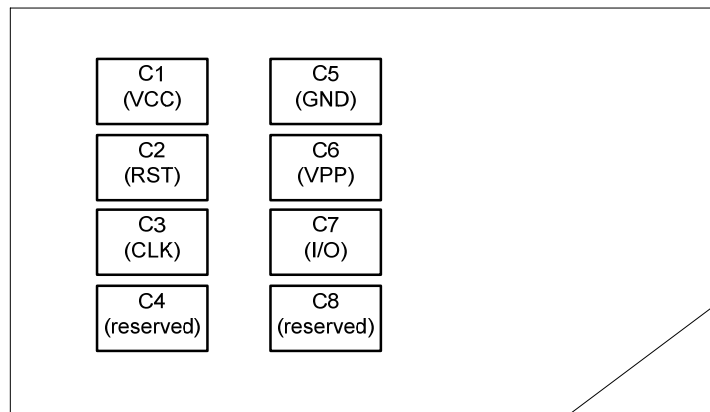
Figure 5: SIM Contact Locations (viewed from contact side)

3.2.2 Typical Interface Design for the SIM

For the purposes of this document, the SIM interface is the interface between the SIM and the laptop at the SIM connector. The SIM interface of the E362 modem provides power, clock, reset and data to the SIM. The data is half duplex, bi-directional, meaning data is transferred in only one direction at any time. The SIM operates in a command/response mode and it will only transmit data in response to a received command. One exception to this is the Answer To Reset (ATR) mode when the SIM transmits data in response to a reset.

The SIM is interrogated during the boot sequence of the E362 modem. First the SIM interface is power sequenced for 1.8V operation. If 1.8 volt operation is unsuccessful then the SIM interface is power sequenced for 3.0 volt operation. Just after boot up of the E362 modem, there will be a large amount of data is transferred over the SIM interface. Later, the data transfer may be sparse, only to ensure that the SIM is present at the interface. The operations indicated in this paragraph are carried out automatically by the U362 modem. The systems integrator does not need to introduce any circuit to distinguish a 1.8V SIM from a 3.0V SIM.

3.2.3 Description of Signals

The SIM interface consists of the signals listed in the Table below.

Table 12: SIM Interface Signals

Name	Pin number of edge connector of E362	SIM card pin
VCC	8	C1
RST	14	C2
CLK	12	C3
Reserved	not connected	C4
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 40, 50	C5
VPP	16	C6
IO	10	C7
Reserved	not connected	C8

GND

The GND signal is the ground for the SIM. All voltages are referenced to this.

VCC

The modem provides the power on the VCC rail. See the Table below for a summary of the 3GPP electrical requirements.

Table 13: VCC Voltage Levels

Symbol	Conditions	Minimum	Maximum	Unit
VCCVCC	3V operation	2.7	3.3	V
VCCVCC	1.8V operation	1.62	1.98	V

RST

RST is driven by the E362 modem. A low signal indicates a reset condition.
See the Table below for a summary of the 3GPP electrical requirements.

Table 14: RST Electrical Requirements

Symbol	Conditions	Minimum	Maximum	Unit
V_{OH}	I_{OHmax} = + 200 µA	0.8 x VCC	VCC	V
V_{OL}	I_{OLmax} = 200 µA	0	0.2 x VCC	V
t_R t_F			400	µs

CLK

The clock signal CLK is driven by the E362 modem. It is the system clock for the SIM. It may be used by the SIM as its processor clock. The frequency of this signal may vary from 1 to 4 MHz. The clock generally does not run continuously. The clock is stopped in between data transfers. See the Table below for a summary of the 3GPP electrical requirements.

Table 15: CLK Electrical Requirements

Symbol	Conditions	Minimum	Maximum	Unit
V_{OH}	I_{OHmax} = + 20 µA	0.7 x VCC	VCC	V
V_{OL}	I_{OLmax} = 20 µA	0	0.2 x VCC	V
t_R t_F			50	ns

I/O

I/O is the bi-directional data signal. The E362 modem may drive this signal low, or may pull it up to VCC. The SIM may drive this signal low, or it may pull it up to VCC.

The I/O signal is much slower than the CLK signal. The default bit time is 372 clock periods. Each data word is 10 bit times (a start bit, eight (8) data bits, and a parity bit). The data signals may be transmitted under the Mark Space convention (high voltage is a binary 1, LSB sent first) or under the reverse convention (low voltage is a binary 1, MSB sent first) depending on the ATR. See the Table below for a summary of the 3GPP electrical requirements.

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Table 16: I/O Electrical Requirements

Symbol	Conditions	Minimum	Maximum	Unit
V_{IH}	$I_{IHmax} = \pm 20$ µA	0.7 x VCC	VCC+0.3	V
V_{IL}	$I_{ILmax} = + 1$ mA	0.3	0.2 x VCC	V
V_{OH}	$I_{OHmax} = + 20$ µA	0.7 x VCC	VCC	V
V_{OL}	VCC = 3V, $I_{OLmax} = 1$mA	0	0.4	V
V_{OL}	VCC = 1.8V, $I_{OLmax} = 1$mA	0	0.3	V
$t_R\ t_F$			1	µs

VPP

VPP is the programming voltage. It is not used and the SIM connector pin should not be connected to the module edge connector.

Reserved

The reserved pins of the SIM connector should not be connected to the module edge connector.

3.2.3. Typical Implementation of SIM card Interface

A typical implementation of the connection between the E362 module connector and the SIM connector is shown in Figure 6. It is advised that ESD protection devices be assembled on the host motherboard. Guidelines for the routing of the signals and the suggested values of the passive components shown in the Figure are indicated below.
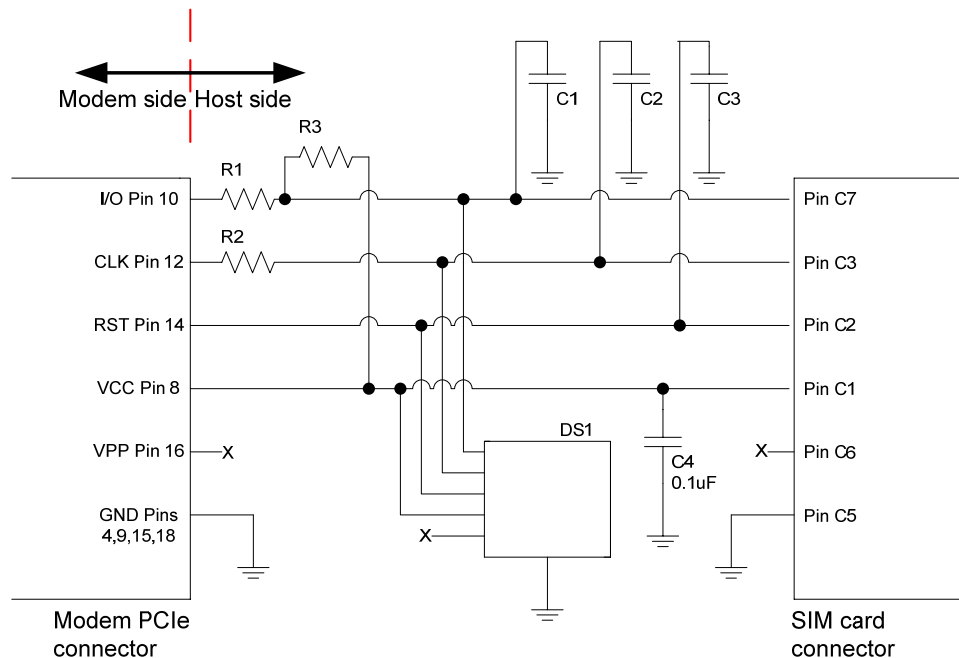

Figure 6: Typical Connection between SIM Connector and PCIe Edge Connector

Capacitors C1, C2, C3

C1, C2 and C3 are not to be populated. They exist if additional filtering is required. These components should be placed close to the SIM connector.

Resistor R1, R2

R1 and R2 should be zero ohms. They exist if additional filtering is required.

Resistor R3

R3 is shown in the circuit as a place holder so that the I/O signal can be pulled up if required.

ESD protection Diode array DS1

DS1 should be a low capacitance ESD diode array (5 pF or less). It is important to minimize the capacitance on the I/O line so data performance is not degraded (deterioration of rise and fall times). DS1 should be placed close to the SIM connector. It is recommended that DS1 meets the limits of IEC61000 4 2, level 4 (±15kV air discharge, ±8kV contact discharge).

Signal routing

The CLK line is a high speed digital signal and care must be taken to ensure it is isolated from other signals. A guard trace should be used between the CLK trace and adjacent traces. A multi-layer PCB with a ground plane should be used. The CLK trace should be routed in an inner layer. CLK traces should be as short, and direct as possible, with no vias. All SIM card interface signals should be routed carefully to avoid being corrupted by each other or external signals.

Capacitor on I/O signal trace

In order to function properly, there is a limit on the amount of capacitance per signal line. The maximum capacitance added by the host (trace plus components) must not exceed 15pF per signal.

Series resistance on the I/O signal trace

I/O traces may also have a pull up on the I/O signal, which would allow sinking of 1 mA into the host motherboard when the I/O signal is driven low by the host motherboard. Series resistance for the I/O signal must be kept very low as the voltage drop across it may cause the output voltage at the connectors to be outside the specified limits.

3.2.4 Certification

Since the SIM card interface is unique to each Notebook PC, the SIM card and Notebook PC together need to undergo several tests for obtaining certification. The electrical test cases are specified in section 27.17.2 in Reference [29].

3.3 Guidelines for Integration of SMBus

In this Section, the SMBus interface of the E362 modem is described.

A 2 line SMBus is supported in hardware, but SMBus is not implemented in firmware other than test provisioning. It may be customized based on customer requirements but would require Novatel Wireless firmware effort.

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The SMBus is a two wire interface through which various system components can communicate with each other and the rest of the system. It is based on the principles of operation of the I^2C Bus. Please see References [3] and [2] for more details on the functional requirements for the SMBus, and Reference [4] for the specification of the I^2C bus.

In general, the SMBus is used for chip to chip communication on a motherboard. The E362 modem is a SMBus Master device, and not a Slave device. Typically, the SMBus protocol can be used by the modem to report to a slave device about various states of the modem, for example the arrival of an email.

SMBus on the modem does not support Clock Stretching and only supports a single master configuration. It does not support slave configuration or multi-master mode.

The two wire interface of the SMBus consists of the SMB_CLK signal and the SMB_DAT signal. These signals are connected to the baseband processor of the modem, and are available on pins 30 and 32 of the edge connector of the E362 module.

Both the SMB_CLK signal and the SMB_DAT signal are bi-directional lines The host SMBus voltage is configurable with the only requirement that is ≥ 1.8V and that each line has a 2.2kΩ resistor pull-up. When the bus is free, both lines are HIGH. The output stages of devices connected to the bus must have an open drain or open collector to perform the wired AND function. Accordingly, on the host side, a pull up resistor is to be present, connecting the Drain pin to the voltage rail of the SMBus. Usually, the voltage rail on the host side is at 3.3V. It is expected that the high power version of the SMBus will be implemented on the host platform (please see Reference [3] for details on the high power version of the SMBus). For high power SMBus, the maximum current through the pull up resistor is 4mA. Then, the value of the pull up resistor should be calculated by taking into consideration the pull up resistors used within the modem on the SMBus traces.

Following is the simplified description of the operation of the I^2C bus.

- The Master (the modem) generates a START condition, signaling all Slave devices on the bus to listen for data.
- The Master writes a 7 bit address, followed by a read/write bit to select the device as a transmitter or receiver.
- The Slave device sends an acknowledgement bit over the Bus to the Master. The Master must read this bit to determine whether or not the addressed Slave device is present on the bus.
- Depending on the value of the read/write bit, any number of 8 bit messages can be transmitted or received by the Master. These messages are specific to the I^2C device used. After 8 message bits are written to the bus, the transmitter will receive an acknowledge bit. The transmission of messages and acknowledgements continues until the entire message is transmitted.
- The message is terminated by the Master with a STOP condition. This frees the Bus for the next master to begin communications.
- Data on the I^2C bus can be transferred at rates of up to 100 kbps in the Standard mode,
- The number of interfaces connected to the bus is solely dependent on the bus capacitance limit of 400 pF.

3.4 Guidelines Related to USB interface

The USB data lines D+ and D- carry differential signals at the maximum rate of 480 Mbps. Accordingly, the design for these trances on the motherboard shall satisfy the requirements of signal integrity and EMI compliance. Please refer to Reference [26] for a detailed description of design considerations.

In general, the following guidelines may be followed.

- Do not route high speed traces close to the D+ and D- traces.
- Keep the trace length of these traces the same.
- USB host requires 90Ω differential characteristic impedance.

4. Getting Started with Development

4.1 General

The E362 modem can be integrated into all Windows driven host platforms, provided that the drivers are properly installed on these platforms. When Novatel Wireless' MobiLink 3™ is installed on a Windows driven platform, all the drivers necessary for the communication between the OS and the module is also installed automatically. The MobiLink 3™ is Novatel Wireless' Windows Application Manager for PCI Express Mini Card modules and USB dongles. The MobiLink 3™ Application Manager provides an easy interface to establish a data connection over a wireless WAN, to change connection parameters, and to view system alerts such as an SMS arrival or signal strength indicator. However, the drivers for Novatel Wireless' modems can be installed manually, independent of MobiLink 3™. Furthermore, after the drivers are installed, Novatel Wireless' NovaCore Client API functions may be made use of to develop a client side connection manager running on the host platform.

After the installation of the E362 modem, the wireless network Carrier (the Service Provider) has to perform activation of the modem before the modem can be used by a user to establish a wireless data call successfully. Verizon Wireless performs the activation by a process called Over the Air Service Provisioning (OTASP). Other Service Providers may use different processes for activation of new modems.

The E362 requires a valid SIM before it can be used on the Service Provider's wireless network. Please contact the Technical Accounts Manager of Novatel Wireless if you encounter difficulties in passing the OTASP phase of activation.

4.2 How to Set Up

For carrying out preliminary evaluation of the modem modules, a Modem Interface Board (Novatel Wireless Part # 01017568) may be used by the integration personnel. Please See Figure 7 for a picture of this Interface Board. This Interface Board can host the modem, and get connected to the host platform over a USB cable. An AC adaptor is provided to provide the power to the Interface Board. Setting up and establishing communication between the modem module and the host platform involves the following steps:

* Hosting the modem on the Interface Board,
* Getting the modem enumerated as a USB device, and determining the host platform's COM Port being used by the modem.
* Setting up and using the HyperTerminal program to communicate with the modem.

Connections among the modem, the Interface Board and the host platform

Ensure that the +3V3SW Enable 2 pin header is shunted as indicated in Figure 7. This shunt enables the status LEDs to light up when the Interface Board is provided with power as would be described later in this Section.

Insert the modem module into the Interface Development Board by sliding the edge connector end of the modem module into the 52 pin Molex connector. Push down the opposite end of the modem module until the 2 black locking tabs snap in.

Connect the Interface Board to the host platform using the USB cable you received along with the Interface Board.

When ready to power up the modem, plug the AC wall adaptor. Ensure that you use the AC wall adaptor provided with the Interface Board. This will supply 5V to the Interface Board.
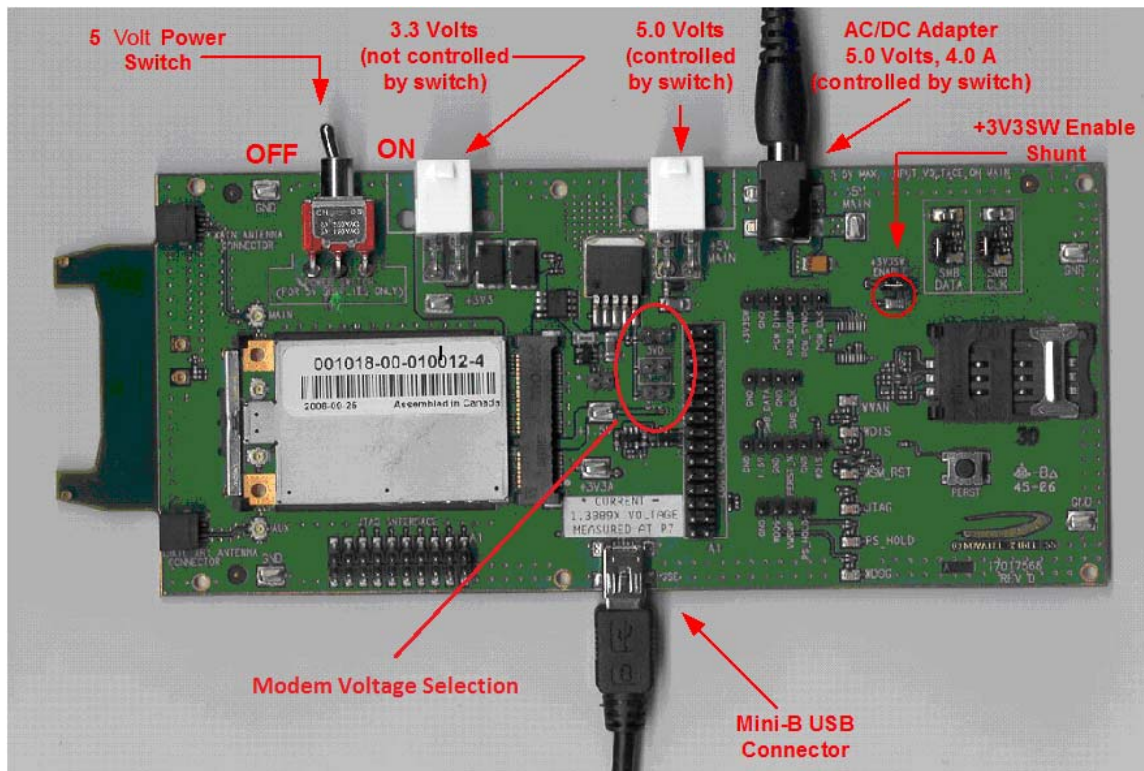

Figure 7: Modem Interface Board and Cables

When power is made available to the Interface Board, switch the red toggle switch to the ON position. (Note: the ON position of the switch is when it is pushed toward the SIM card connector on the Interface Board; the OFF position is when it is pushed away from the SIM card connector. These positions are illustrated in Figure 7.).

If desired, the Interface Board can be powered by a bench top DC power supply through the appropriate white, 4 pin Molex power connector (see Figure 7). J11 is for external 5V input, and J12 is for external 3.3V input. The current rating of the external DC supply should be at least 4.0A.

The toggle switch provides ON/OFF control for both 5V input sources, but NOT the 3.3V source. The Interface Board is powered on as soon as the 3.3V is applied.

MODEM VOLTAGE SELECTION: Refer to Figure 7 to locate the 2 pin headers that select 3V0, 3V3, or 3V6 DC power to the modem. The E362 modem utilizes nominal 3.3V supply power specified in the PCIe Mini card standard, so ensure that the 3V3 2 pin header is shunted with a jumper. This is the default shunt position. Note that if no jumper is installed the supply power to the modem defaults to 3V0 and may result in lower than expected transmitter power. Also note that these 2 pin headers will only control the voltage to the modem from the external 5.0V sources (AC/DC adapter and J11), but NOT from the external 3V3 source via J12.

After the modem is powered up and enumerated by the host platform, the host platform generally generates an audible indication.

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Determining the host platform's Active Primary COM Port

To verify that the host platform has recognized the modem, and to examine which COM Port is used by the modem, please use the following command links;

- Start → Control Panel → Phone and Modem Options, and then click on the Modems tab within the Phone and Modem Options window.
- After the command sequence indicated above, a Window similar to the one shown in Figure 8 below will be displayed.
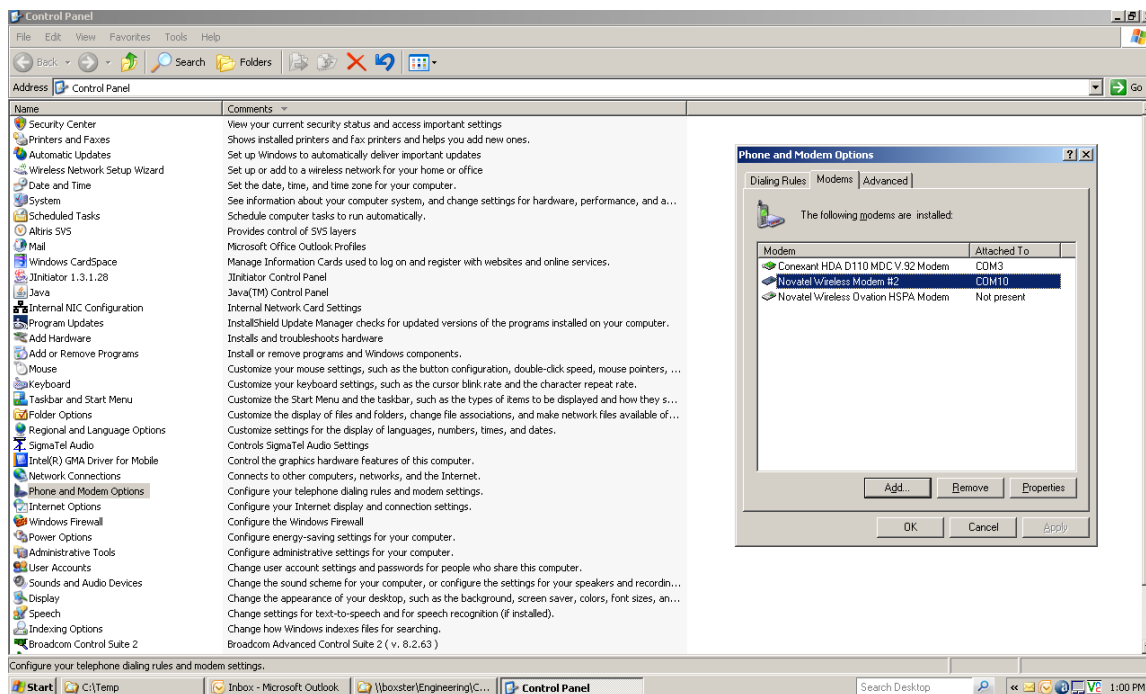

Figure 8: Phone and Modems Options Window

- Look on the Window for the listing of the Novatel Wireless Modem (E362). If such an item is present in the listing, you will see to the right of this item the COM port the device is attached to. Take note of this COM Port Number. If you do not see any COM port No. for this item and you only see "Not Present", it is an indication that the modem is not being recognized and is not attached to a COM Port of the host platform. In this case, make sure the USB cable and the power cable are properly connected at both ends.

Determining the host platform's Active Secondary or Status COM Port

To verify what the numbers of the secondary port and the status port are, use the following command links;

- Start → Control Panel → System.

- Double click on the System icon and then click on the Hardware Tab within the System Properties window. Now click on the Device Manager tab. In the Device Manager window, click on the "+" sign beside Modems to expand this item. You should now see the Novatel Wireless Modem, or something similar to the list as shown in Figure 9. Now click on the "+" sign beside Ports (COM & LPT) to expand this item. You should now see the Novatel Wireless Status Port (COMXX) listed here. The XX is the COM Port number.

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- Refer to Figure 9 below, which also shows the Application Port and GPS Port. The Novatel Wireless Application Port displayed here will be used for NovaCore API to communicate with the modem. The Novatel Wireless GPS Port will be used to get NMEA data for GPS/LBS supported device.
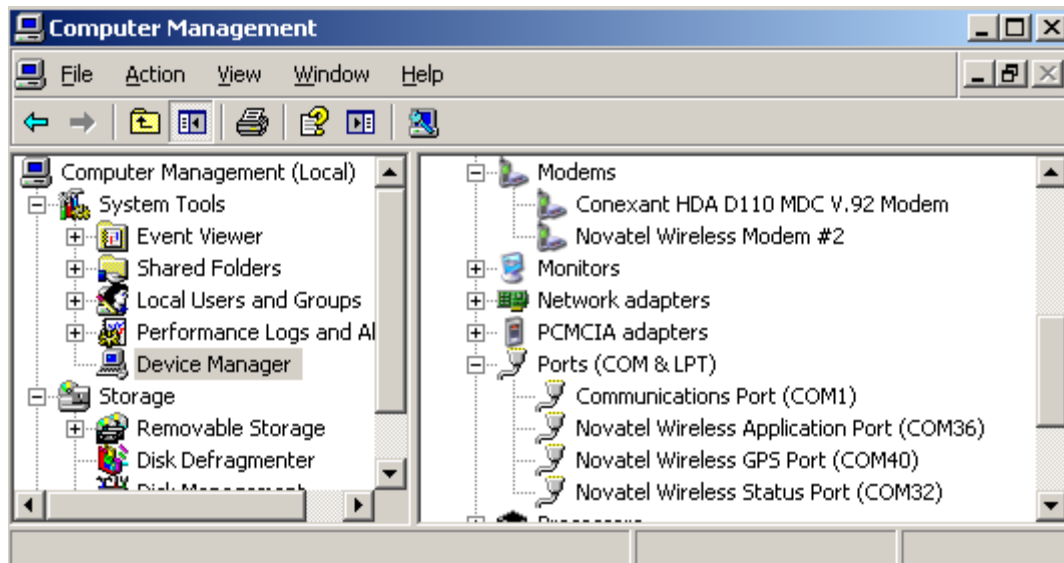

Figure 9: Device Manager Window Showing the Computer's Active COM Ports

Setting up HyperTerminal to communicate with the modem

After ensuring that the ports are available as described above, tests may be carried out over these ports. For conducting these tests, ensure the HyperTerminal application of the Windows OS[1]. Before proceeding for these tests, ensure that the modem is still powered on and is connected to the host platform over the USB cable, and it has been enumerated by the host.

Open up a HyperTerminal session by navigating to;

- Start → All Programs → Accessories → Communications → HyperTerminal.

- Type in a Connection Description title defined by you, typically the COM Port number that was identified earlier. Click 'OK'. Then you will see a display similar to the shown Figure 10.

---

[1] Note that Windows Vista and Windows 7 may not come with HyperTerminal. The user may need to install it separately.
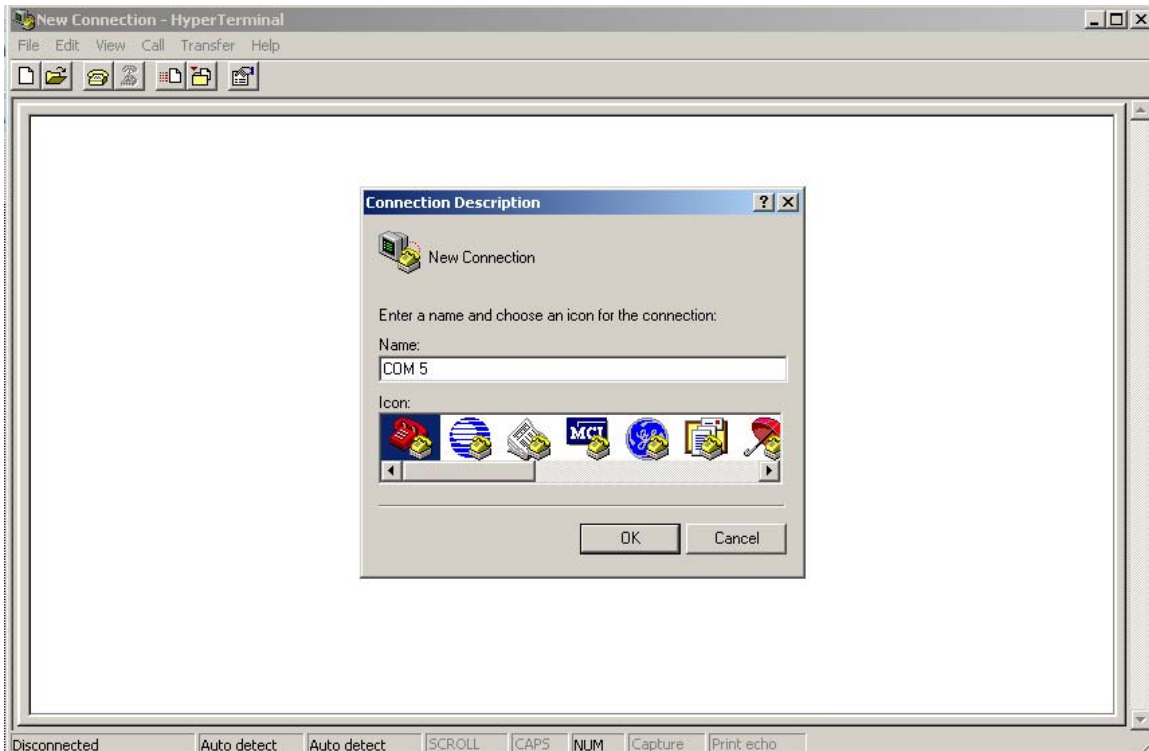
Proprietary and Confidential

Figure 10: HyperTerminal Connection Description Window

- In the "Connect Using" pull down menu, select the proper COM port (Primary COM port number) that the host is using to communicate with the modem, then click 'OK'. You will see a display similar to the one shown in Figure 11 below.

Figure 11: HyperTerminal COM Port Selection Window

- When the 'COMXX Properties' window opens up, click the OK button as there is no need to select or modify any of these settings. Typically, the display will be as indicated in Figure 12 below.
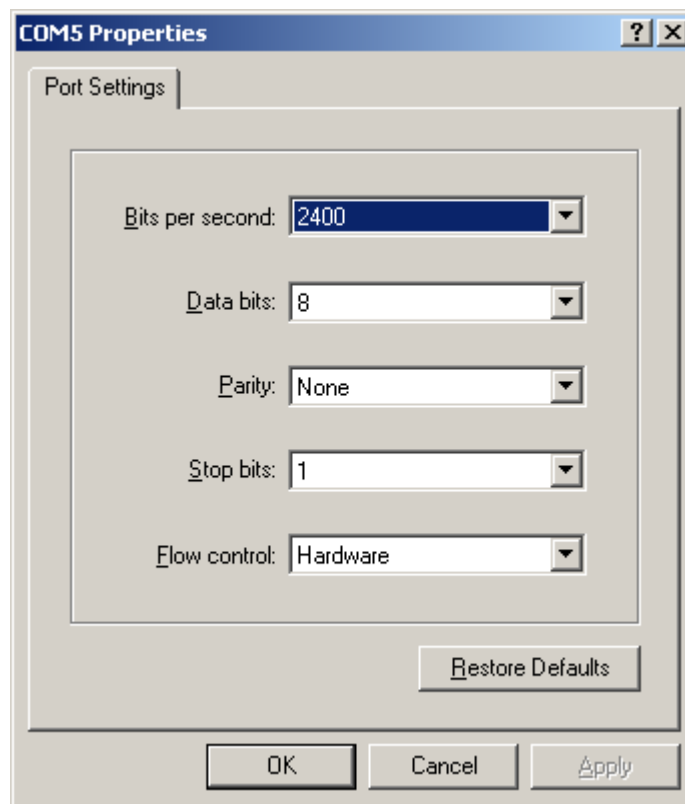

Figure 12: HyperTerminal Properties Window

Now the modem should be automatically connected, as will be indicated in the bottom left corner of the HyperTerminal window. To further ensure that the connection to the modem is successful, type "ATI" and press ENTER. In response, the modem manufacturer, model number, FW revision and IMEI information will then be returned as is shown in Figure 13 below.

If no information is returned in the HyperTerminal window after typing ATI, then click on the Disconnect tab at the top of the HyperTerminal window (or click on Call\Disconnect). Reconnect by clicking on the Connect tab at the top of the HyperTerminal window (or click on Call\Connect). Now type the command ATE to enable the "Echo" function of the modem. When the Echo function is active, it will allow the characters typed on the key board to be displayed on the HyperTerminal window. After typing the ATE command, type the command ATI. As a response to this command, the modem will display information on the HyperTerminal window, similar to the display indicated in Figure 13.
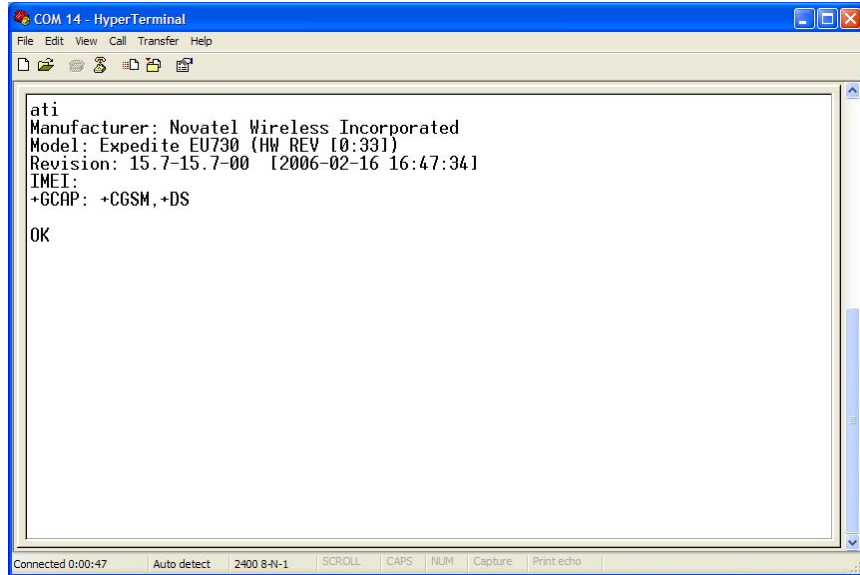
Figure 13: HyperTerminal Communication Window

5. Host Software

As indicated in Section 2.2.4, the E362 modem is a USB 2.0 High Speed end point device. Essentially, this modem provides wireless Internet connectivity to the host. In this section, a brief description is given on the host side Drivers, Tools and Application Programs to make the developer familiar with them. Some of the Tools and Application Programs are distributed either through CD or may be downloaded over the Internet.
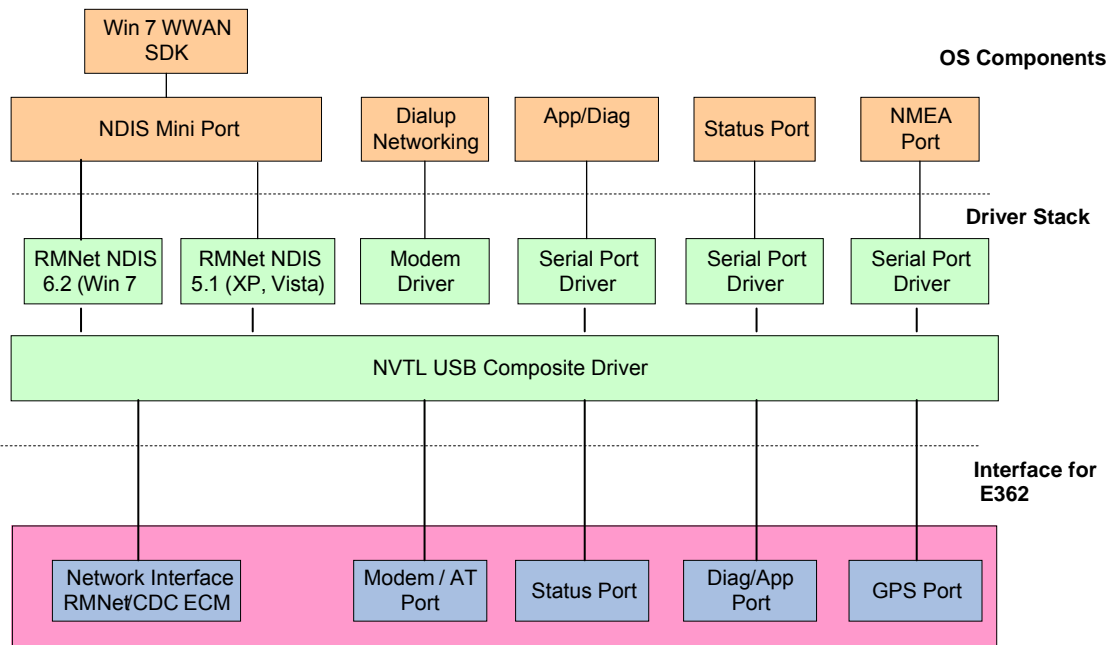
5.1 Drivers

Figure 14: Block Diagram of Driver Components on Host

Various modules on the host side Driver are indicated in Figure 14. Please note that the ports indicated at the Interface for E362 (GPS port, Diag/App port, Ststus port, etc.) are Virtual COM ports of the USB interface, and these ports are implemented on the host platform using the Communication Device Class (CDC) drivers.

5.2 NovaCore SDK

A software framework called Novacore has been developed by Novatel Wireless to be used by systems integrators and application developers. This framework will be called the NovaCore SDK for the rest of this document. The NovaCore SDK can be downloaded from the following site:

http://www.nvtl.com/index.php?option=com_content&view=article&id=8&Itemid=254

The Integrators and Developers are required to register themselves at this site before they would be enabled to download the information related to NovaCore. The link indicated above can be used to arrive at a site wherein the latest SDK drivers, APIs and software applications could be

found. Information obtained from this link also helps one to leverage the capabilities of various hardware solutions of Novatel Wireless. This link also offers a venue for exchanging tips among developers of fellow industries, and a forum to discuss about the latest news on development.

The Figure below illustrates how the NovaCore framework helps in the integration of software applications.
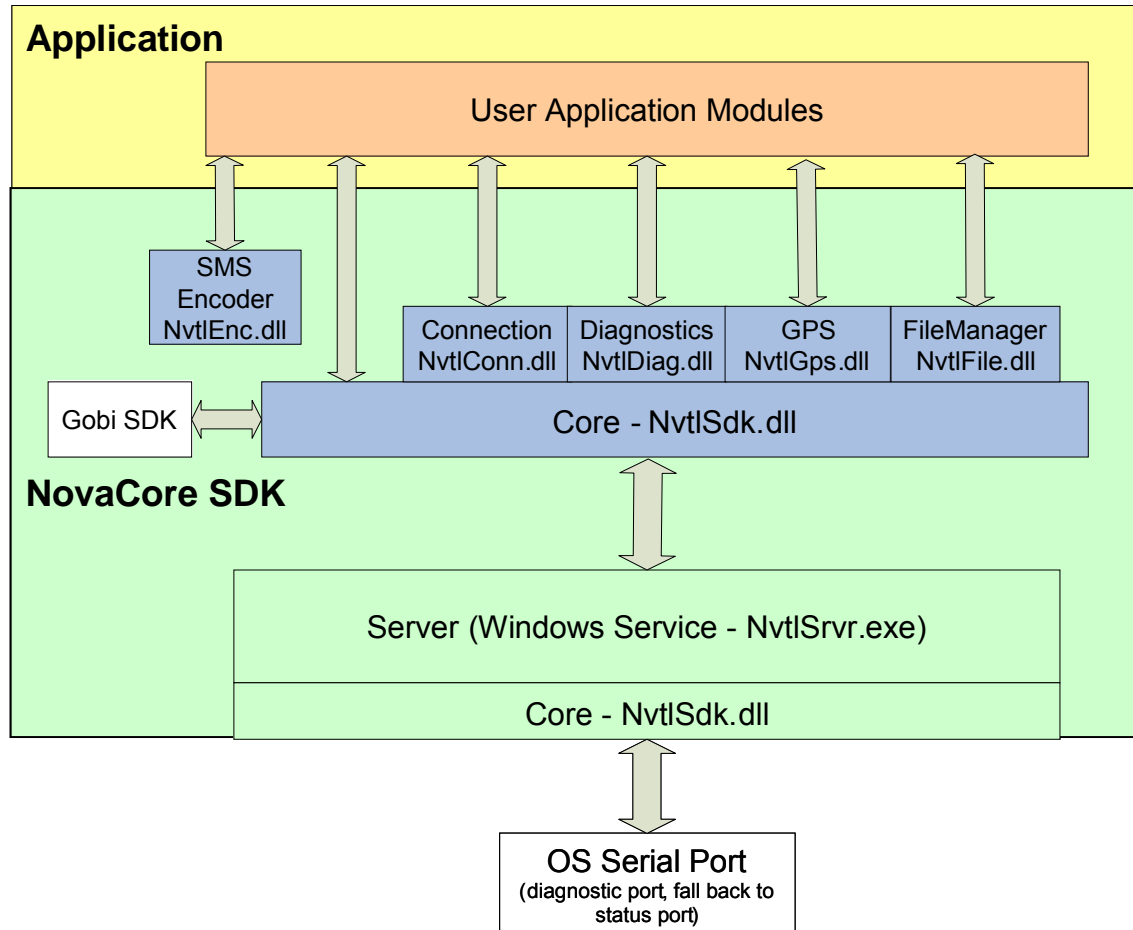

Figure 15: Integration of Software Application Using NovaCore SDK

Technical Support Contacts

For technical support, following is the contact address:
URL: http://www.nvtl.com/support/index.html

Email: support@novatelwireless.com

5.3 MobiLink 3™ Connection Manager

The Novatel Wireless' MobiLink 3™ Communications Software Suite is a family of wireless connectivity applications for mobile devices to connect to the Internet using wireless wide area Networks (WWAN), WiFi access or Ethernet access. Using MobiLink 3™, an application can quickly and easily access the Internet and corporate networks anytime, anywhere, and make use of associated software applications such as email.

MobiLink 3™ is optimally engineered to work with all of Novatel Wireless' modems for best in class 3G and 4G wireless broadband access solutions, and may be used to install and configure the E362 modem. E362 customers also have the option to use their own preferred Connection Manager instead of the MobiLink 3™ Connection Manager.
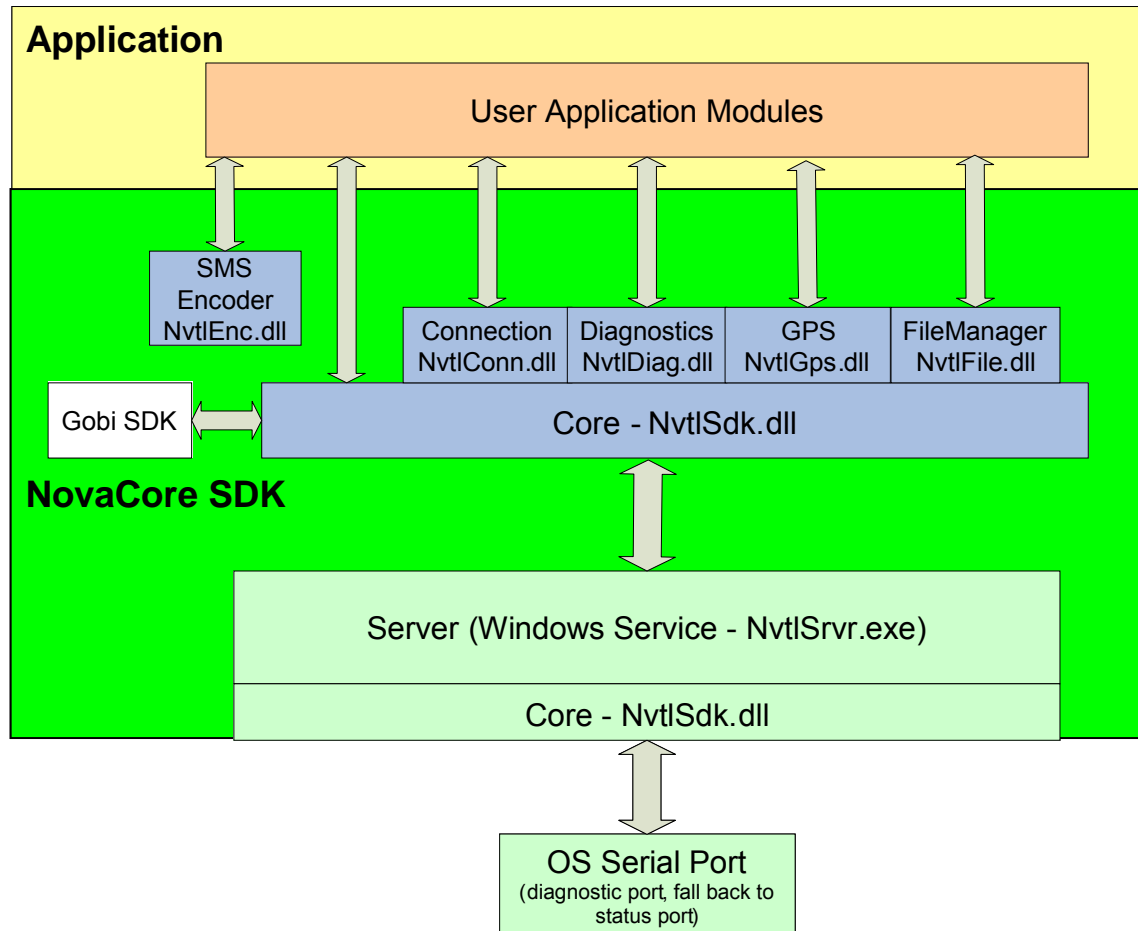

Figure 16: MobiLink™ in the Context of NovaCore

The MobiLink3™ Communications Software Suite of applications contains a Messaging Client that manages a 2 way SMS operations, an Address Book Client that manages contacts and phone numbers, a Connection Manager that manages the connectivity, and a customization utility to manage, generate install customization settings. Figure 16 illustrates the MobiLink in the context of NovaCore.

The important features offered by Mobilink™ are indicated below:

- AT Command Set Support per IS 707,

- Fully compatible and interoperable with current Microsoft™ OS platforms: 32/64 bit Windows XP, 32/64 bit Windows Vista, 32/64 bit Windows 7

- Integrated drivers for Windows OS, configurable as either a modem or network card

- PCI Express Mini card compatible hardware interface

- Compatibility with all major brands of PC platforms

- Sleep mode capabilities (low power mode)

- Uses common base technology shared with OEM Module

- IS 683A compliant Over The Air activation and parameter update capabilities

- On line help, getting started guide, documentation

- All software applications necessary to communicate with the PCI Express Mini Card will operate with above supported systems.

- All software supports 640x480, 640x240, and 800x600 color and monochrome displays

- MobiLink 3™ allows the user to configure the modem easily

- MobiLink 3™ provides diagnostic capability

- MobiLink 3™ provides a Help menu that is Context Sensitive

If required, contact Novatel Wireless technical support for the MobiLink 3™ User Guide, and supported AT commands.

5.4 Novaspeed™

Novatel Wireless' Novaspeed™ is an Application Software that can be run within the modem. The Application Software helps to obtain higher throughput rates over 3G wireless WAN connections. Perhaps, such a performance enhancement is not required for 4G wireless WAN connections. If a customer needs such performance enhancements over 3G wireless WAN connections, he may contact Novatel Wireless for its implementation.

Appendix A - Compliance with Regulatory Standards

A.1 FCC Requirements Related to Radio Interference

The modem described in this document have been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules and Industry Canada ICES 003. These limits are designed to provide reasonable protection against harmful interference in a residential installation. A modem radiates 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 which the receiver is connected.
- Contact your service provider for help.

Warning: Changes or modifications made to the modem not expressly approved by Novatel Wireless may void the FCC authorization to operate this equipment.

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.

A.2 FCC Requirements Related to Exposure to Radio Frequencies

In general, for the United States Market, the embedded wireless modules are treated as "mobile devices" as per FCC CFR47 paragraph 2.1091. A mobile device is defined as "a transmitting device designed to be used in locations other than fixed locations and to generally be used in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter radiating structure(s) and the body of the user or nearby persons."

Please note that certain Europe specific requirements and certifications listed below do not apply to modems which are intended to be used only in the North American market.

A.3 Requirements of CE

The modems for the European Market will be tested for conformance with the regulatory requirements of the European Union and, accordingly, they have attained CE Marking. The CE Mark is a conformity marking consisting of the letters "CE". The CE Mark applies to products regulated by certain European health, safety and environmental protection legislation. The CE Mark is obligatory for products it applies to: the manufacturer affixes the marking in order to be allowed to sell his product in the European market.

A.4 Requirements of R&TTE

Compliance with this directive is mandatory for European operation and the directive applies to products using the radio frequency spectrum and all equipment attached to public telecommunications networks.

The modem described in this document conforms to the essential requirements of the Radio Communications and Telecommunications Terminal Equipment Directive (R&TTE) 1999/5/EC with respect to the following articles:

- 3.1a Safety
- 3.1b EMC
- 3.2 Spectrum

A notified body will determine whether the modem has properly demonstrated that the requirements of the directive have been met and has issued a favorable certificate of expert opinion. As such the device will bear the notified body number 0682 after the CE Mark.

A.5 Requirements of PCS Type Certification Review Board (PTCRB)

PTCRB Certification is mandated and the modem is technically evaluated to meet the minimum requirements for registration on the PTCRB Operators' networks. The purpose of the PTCRB is to provide the framework within which GSM Mobile Equipment (ME) Type Certification can take place for members of the PTCRB. The PTCRB process is recommended for all Manufacturers who wish to have their products operating within the areas served by the PTCRB Operators. This includes but is not limited to determination of the test specifications and methods to implement the Type Certification process for GSM Mobile Equipment.

PTCRB type certification will be based on GSM and OMA (Open Mobile Alliance) Specifications with modifications per North American Standards and additional requirements from FCC rules, and any other government agency that may have jurisdiction and (or) competence in the matter. Additions to the PTCRB Specifications will be developed by the GSM operators. The additions will be limited to MS related features. The PTCRB document NAPRD 03 (Permanent Reference Document) will be modified to include references to the above specifications once they are written and accepted by majority of the review board.

To learn more about device certifications, please visit the PTCRB Website. You must sign up as a member to gain access.

A.6 Requirements of Global Certification Forum (GCF),

The Global Certification Forum (GCF) is an independent organization with a wide ranging membership of operators, equipment manufacturers and other interested parties. The actions of the Forum are actively supported by key staff from the Association Technical Projects operation and by the Association Executive Management Committee.

GCF is recommended but not mandatory for attachment to the European Network. It is a partnership between Network Operators and Terminal Manufacturers and allows independent interoperability validation of the 2G and 3G mobile wireless terminal. GCF is typically required for formal carrier technical acceptance of the mobile, wireless terminal. From the 26th of December, 2010 onwards, the GCF Certification process can be applied to certain LTE devices also.

Membership of GCF is entirely voluntary. Full GCF membership is open to mobile terminal manufacturers and network operators. Other interested members of the mobile wireless community, including test laboratories and test equipment manufacturers, may participate in GCF as observers.

The current membership includes almost 150 network operators worldwide, more than 35 leading terminal manufacturers and over 50 test equipment manufactures. Members decide upon the organization and administration of the forum at regular Steering Group meetings. Technical issues associated with testing new terminals and features are reviewed at regular Agreement Group meetings by manufacturers, test laboratories and other observers.

To learn more about device certifications, please visit the GCF Website. The website identifies manufacturers, Terminal names and the date on which the Terminal was certified. You must sign up as a member to gain full access.

A.7 Conformance with the Windows Certified Platforms

The NovaCore Software Developers Kit API will interface with your top level applications and provide the abstraction of the modem specific interfaces to the upper applications. Please refer to the NovaCore API Interface Appendix for details.
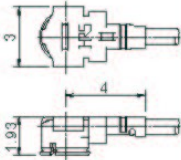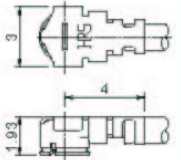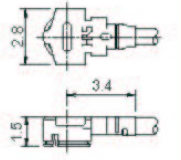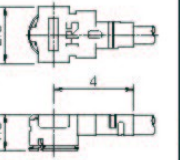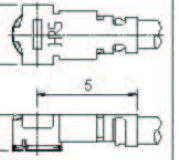
Please refer to the NovaCore SDK chapter for details on developing applications and communicating with the modem on Windows platforms.

Appendix B - Specification of Parts

B.1 RF Connector

Hirose U.FL series, with U.FL R SMT receptacle mating to the following connectors illustrated. Note that .this connector is designed for a limited number of insertions. For an embedded application this is expected to be acceptable.

■Cable Assembly (Plug)

Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7

●Cable Guide

Description	Cable Type	Cable Specification					Nominal attenuation	
		Inner Conductor*	Dielectric Diameter	Outer Conductor*	Jacket Diameter	Nominal Impedance	At 3GHz	At 6GHz
Dia.0.81mm Coaxial Cable	04	7/0.05 SA (AWG36)	Dia.0.40 PFA	Single Shield SA	Dia.0.81 PFA	50 ohms	6.45dB/m	9.42dB/m
Dia.1.13mm Coaxial Cable	068	7/0.08 SA (AWG32)	Dia.0.68 FEP	Single Shield SA[TA]	Dia.1.13 FEP	50 ohms	3.43dB/m [3.73dB/m]	5.13dB/m [5.44dB/m]
Dia.1.32mm Coaxial Cable	066	7/0.08 SA (AWG32)	Dia.0.66 FEP	Double Shield TA	Dia.1.32 FEP	50 ohms	3.8dB/m	5.6dB/m
Dia.1mm Coaxial Cable	062	7/0.071 SA (AWG33)	Dia.0.62 FEP	Tape, single Shield TAT	Dia.1 FEP	50 ohms	3.1dB/m	4.4dB/m
Dia.1.37mm Coaxial Cable	088	7/0.102 SA (AWG30)	Dia.0.88 FEP	Single Shield TA	Dia.1.37 FEP	50 ohms	2.8dB/m	4.3dB/m

(data as provided by cable suppliers, for reference only)
＊ SA : Silver plated annealed copper wire, TA : Tin plated annealed copper wire, TAT : Tin plated copper wire alloyed with tin

Figure 17: RF Connector

B.2 Mini Card Connector

The Molex 67910 series, mates with the mini PCI Express Card. Use with Latch 48099 0003.

Figure 18: Mini Card Connector

Appendix C - Glossary

Abbreviations given in 3GPP TR 21.905 [15] and the following apply.

AT Commands
AT commands are a language type that enables PC communications software to give the modem directions. The term **AT** comes from the command terminology which always begins with **attention**, or AT.

Carrier
See Service Provider

Circuit Switched Data
A wireless network connection established, using a single circuit that extends from you, directly through the network to your call's destination. Opposite of packet switched.

CLI
Command Line Interface.

Code Division Multiple Access (CDMA)
Code Division Multiple Access is a spread spectrum wireless access technology that allows multiple users to share the same physical RF channel (1.25MHz for single carrier direct spread 1X) by use of orthogonal code spreading.

Connection Profile
See Network Connection Profiles

dBm
The power ratio in decibels (dB) of the power referenced to one milliwatt (mW).

Default Network Connection Profile
The default network connection profile is the connection profile, chosen by you that the Modem Manager will use to connect to the network. The default network connection profile can be thought of as the **active** network connection profile.

Edge Technologies
Edge (Enhanced Data for Global Evolution) is an enhanced version of GPRS providing three to four times more capacity and data throughput. Average speeds range from 100 to 130 kbps with theoretical peak data rates of 473 kbps. Average rates are fast enough to support a wide range of advanced data services such as streaming audio and video, fast Internet access and large file downloads, EDGE can also support a greater range of enterprise applications, and more multimedia applications including push to talk services.

Firmware
Firmware is a program or set of programs that have been set permanently into a computer chip. The programs themselves usually are low level programs that directly manipulate or interact with the hardware. An example of firmware is your desktop computer's BIOS.

General Packet Radio Service (GPRS)
GRPS is a packet based, always on data connection standard.

High Speed Downlink Packet Access (HSDPA)
HSDPA is a packet based data service that improves upon UMTS by increasing speeds to 500 800 kbps with peak data rates of up to 10 Mbps (five times faster than UMTS and other 3G technologies) in a 5 MHz channel. In addition, HSDPA significantly improves packet data throughput capacity, thereby increasing the number of users that can be supported at higher data rates on a single radio carrier.

IMEI
IMEI stands for International Mobile Station Equipment Identity.

Mega Hertz (MHz)
One million hertz. Hertz is another word for cycles in a radio frequency.

Mobile Station (MS)
The device being used to receive/transmit data and/or voice.

Mobile Terminal (MT)

NDIS   Network Driver Interface Specification
This is an API developed for Microsoft Windows OS to be used with Network Interface Cards.

Network Connection Profiles
A network connection profile is a group of connection settings that define a specific network connection to the Modem Manager. This includes such settings as network ID, network password, APN, DNS addresses and so on.

Original Equipment Manufacturer (OEM)
The original manufacturer of a pieces of equipment, typically complete boards, duplexers or enclosures etc.

Over The Air (OTA)

Packet
A short block of data transmitted across a network.

Packet Data Network (PDN)
Network that carries user data in packets. ex. Internet and X.25

Radio Link Protocol (RLP)

Service Provider
A company that provides network connections to the Internet.

Short Message Service (SMS)
Short messages either in binary (160 characters) or text messages (140 bytes) format.

Terminal Equipment (TE)

U$_m$
Mobile to Base Station air interface link.

Universal Product Support Tool (UPST)
The Universal Product Support Tool (UPST) consists of the UPST Framework and UPST device DLLs. The UPST Framework is a Windows 32 application (UPST.exe) that uses UPST device Dynamic Link Libraries (DLLs) to provide basic device provisioning functions such as Refurbish, Software upgrades, Preferred Roaming List (PRL) upgrades, and Phone Settings programming.

User Datagram Protocol (UDP)
Another protocol on top of IP.

Wireless IP Network
A wireless network (e.g. CDMA) that uses Internet Protocol (IP)