LN930 M.2 Hardware User Guide

1VV0301078 Rev.10 – 2015-11-11

Making machines talk.

APPLICABILITY TABLE

PRODUCT
LN930
LN930-AP

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Contents

1 Introduction

This document is a technical specification for Telit's next generation form factor M.2 module family. The next generation form factor M.2 module family is a natural transition from the PCI Express Mini Card and Half Mini Card to a smaller form factor size.
The M.2 Card Type 3042 offers single sided component mounting, 75 pins (8 dedicated for key), in a compact size (30 mm x 42 mm). A range of 2G/3G/4G (LTE) M.2 modules supporting multiple operating systems and unique features in the WWAN Card Type 3042 form factor are available.

1.1 Scope

The document will cover the features of the M.2 modules presently available. It will also identify the M.2 module application interface along with hardware, software, reliability, and mechanical specifications.

1.2 Purpose

The intent of this document is to provide design guidelines and information for each M.2 module.
In addition to the M.2 module family features and performance metrics, this document describes the interface signals, operating conditions, physical and mechanical requirements of the M.2 cards.

1.3 Audience

This document is intended for editors who are about to write or edit documentation for Telit.

1.4 Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
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Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

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Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.5 Document Organization

This document contains the following chapters (sample):

"Chapter 1: "Introduction" provides a scope for this document, target audience, contact and support information, and text conventions.

"Chapter 2: "Chapter two" gives an overview of the features of the product.

"Chapter 3: "Chapter three" describes in details the characteristics of the product.

"Chapter 6: "Conformity Assessment Issues" provides some fundamental hints about the conformity assessment that the final application might need.

"Chapter 7: "Safety Recommendation" provides some safety recommendations that must be follow by the customer in the design of the application that makes use of the AA99-XXX.

1.6 Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.7 Related Documents

- TBA

2 M.2 Overview

This section will provide an overview of the standard features of a M.2 Card, information on the various SKUs of 2G/3G/4G (LTE) M.2 modules along with a respective functional block diagram of each SKU.

2.1 SKUs - 2G/3G/LTE M.2 Modules

There are five different M.2 modules available in the M.2 Card Type 3042 form factor:

- HN930 - HSPA+
- LN930-AP - APAC LTE
- LN930 - LTE

A comparison of the features, RF band Support, and data rates for the various M.2 modules is shown in Table 1 through Table 3

Table 1 M.2 Module - General Feature

Feature	Description	Additional Information	M.2 module		
			HN930	LN930-AP	LN930
Mechanical	M.2 Card Type 3042 Slot B	30 mm x 42 mm Pin count: 75 (67 usable, 8 slot)	x	x	x
Operating Voltage	3.3 V +/- 5%	-	x	x	x
Operating Temperature	-10˚C to +55˚C – Normal +55˚C to +70˚C – Extended	Extreme - This is the surrounding air temperature of the module inside the platform when the card is fully operating at worst case condition	x	x	x
Application Interface (75 pin card)	Interprocessor Communications	USB 2.0 High-speed	x	x	x
	USIM w/ Card Detect	SIM_CLK, SIM_RESET, SIM_IO, SIM_PWR, SIM_DETECT	x	x	x
	M.2 Control	Full_Card_Power_On_Off	x	x	x
		Reset#	x	x	x
		W_DISABLE#	x	x	x
		LED #1	x	x	x
		DPR (Body SAR)	x	x	x
		Wake on WWAN	x	x	x
		GNSS Disable	x	x	x
	Global Positioning (GPS/ GLONASS)	I2C_SCL, I2C_SDA, I2_IRQ, CLKOUT, TX_BLANKING	x	x	x
	Antenna Tuning	(4) GPO (RF Transceiver)	-	x	x
	RF Coexistence	(3) GPIO	-	x	x
RF Antenna	Main & Diversity/ GNSS	Separate coax connectors	x	x	x
Debug	JTAG	-	x	x	x
	ETM11	-	-	x	x
	MIPI PTI	-	-	x	X

Table 2. M.2 Module - RF Band Support

RF Band	UE Transmit	UE Receive	M.2 Module								
			HN930			LN930-AP			LN930		
			GSM	UMTS	LTE	GSM	UMTS	LTE	GSM	UMTS	LTE
001 I	1920 MHz - 1980 MHz	2110 MHz - 2170 MHz		x			x	x		x	x
002 II	1850 MHz - 1910 MHz	1930 MHz - 1990 MHz	x	x					x	x	x
003 III	1710 MHz - 1785 MHz	1805 MHz - 1880 MHz	x					x	x		x
004 IV	1710 MHz - 1755 MHz	2110 MHz - 2155 MHz		x						x	x
005 V	824 MHz - 849 MHz	869 MHz - 894 MHz	x	x					x	x	x
006 VI	830 MHz - 840 MHz	875 MHz - 885 MHz					x				
007 VII	2500 MHz - 2570 MHz	2620 MHz - 2690 MHz									x
008 VIII	880 MHz - 915 MHz	925 MHz - 960 MHz	x	x			x	x	x	x	x
009 IX	1749.9 MHz - 1784.9 MHz	1844.9 MHz - 1879.9 MHz						x			
010 X	1710 MHz - 1770 MHz	2110 MHz - 2170 MHz									
011 XI	1427.9 MHz - 1447.9 MHz	1475.9 MHz - 1495.9 MHz					x	x			
012 XII	699 MHz - 716 MHz	729 MHz - 746 MHz									

013 XIII	777 MHz - 787 MHz	746 MHz - 756 MHz									x
014 XIV	788 MHz - 798 MHz	758 MHz - 768 MHz									
017 XVII	704 MHz - 716 MHz	7734 MHz - 746 MHz									x
018 XVIII	815 MHz -830 MHz	860 MHz -875 MHz						x			x
019 XIX	830 MHz - 845 MHz	875 MHz - 890 MHz					x	x			x
020 XX	832 MHz - 862 MHz	791 MHz - 821 MHz									x
021 XXI	1447.9 MHz - 1462.9 MHz	1495.9 MHz - 1510.9 MHz						x			
022 XXII	3410 MHz - 3490 MHz	3510 MHz - 3590 MHz									
023 XXIII	2000 MHz - 2020 MHz	2180 MHz - 2200 MHz									
024 XXIV	1626.5 MHz - 1660.5 MHz	1525 MHz - 1559 MHz									
025 XXV	1850 MHz - 1915 MHz	1930 MHz - 1995 MHz									
026 XXVI	814 MHz - 849 MHz	859 MHz - 894 MHz						x			
027 XXVII	806 MHz - 824 MHz	851 MHz - 869 MHz									
028 XXVIII	703 MHz - 748 MHz	758 MHz - 803 MHz									

029 XXIX	1850 MHz - 1910 MHz or 1710 MHz - 1755 MHz	716 MHz - 728 MHz									
001 I	1920 MHz - 1980 MHz	2110 MHz - 2170 MHz									

Table 3. M.2 Module - Data Services

Data Service	M.2 module		
	HN930	LN930-AP	LN930
GPRS Class 33: DL 85.6 kbps, UL 85.6 kbps	x	-	x
EDGE Class 33: DL 236.8 kbps, UL 236.8 kbps	x	-	x
WCDMA: DL 384 kbps, UL 384 kbps	x	x	x
HSPA+: DL 21 Mbps, UL 5.7 Mbps	x	x	x
HSPA+: DL 42 Mbps, UL 5.7 Mbps	-	x	x
LTE FDD: DL: 100 Mbps, UL 50 Mbps	-	x	x
LTE FDD: DL: 150 Mbps, UL 50 Mbps	-	x	x

Module supports DL 150 Mbps in LN930. This is only for generic SW and VZW SW, but not for AT&T SW.

2.2 M.2 Module – Block Diagrams

2.2.1 M.2 HN930 Module

The M.2 HSPA+ module is Intel's Next Generation Form Factor design based on Intel's XMM™6260 modem platform. The M.2 HSPA+ card is a dual-mode (UMTS/GSM) 3GPP release 7 HSPA+ modem.

The M.2 HSPA+ module includes support at the 75 pin application interface for M.2 Control, USB 2.0 HS, GNSS, and USIM. Antenna Tuning is not supported.

A block diagram of the M.2 HSPA+ module is shown in Figure 1.

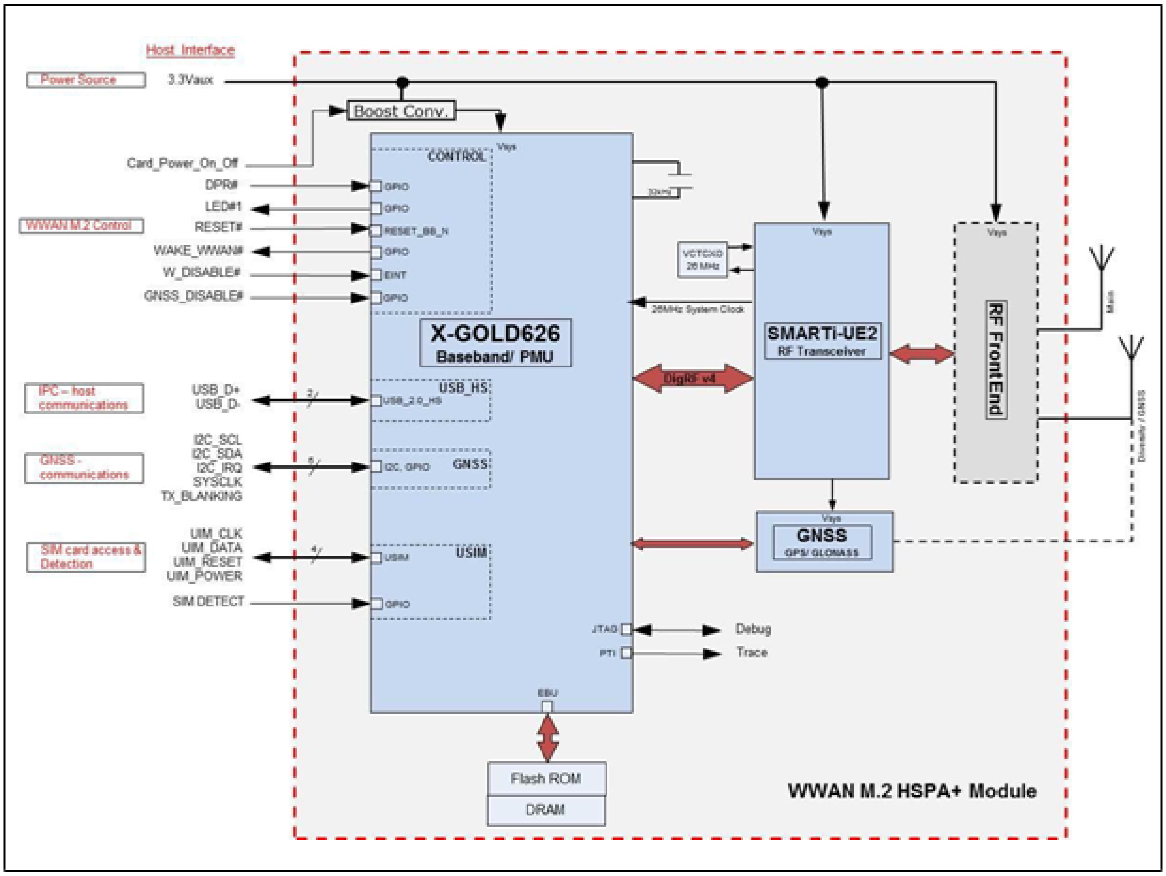

Figure 1 M.2 HSPA+ Block Diagram

2.2.2 M.2 LN930-AP Module

The M.2 APAC LTE module is another Intel design based on the XMM™7160 modem platform. The module has a targeted area of operation in the Asia Pacific rim and offers 3G and LTE datacard functionality, 2G Functionality is not supported.

The M.2 APC LTE module includes support at the 75 pin application interface for M.2 Control, USB 2.0 HS, GNSS, USIM and Antenna Tuning.

A block diagram of the M.2 APAC LTE module is shown in Figure 2.

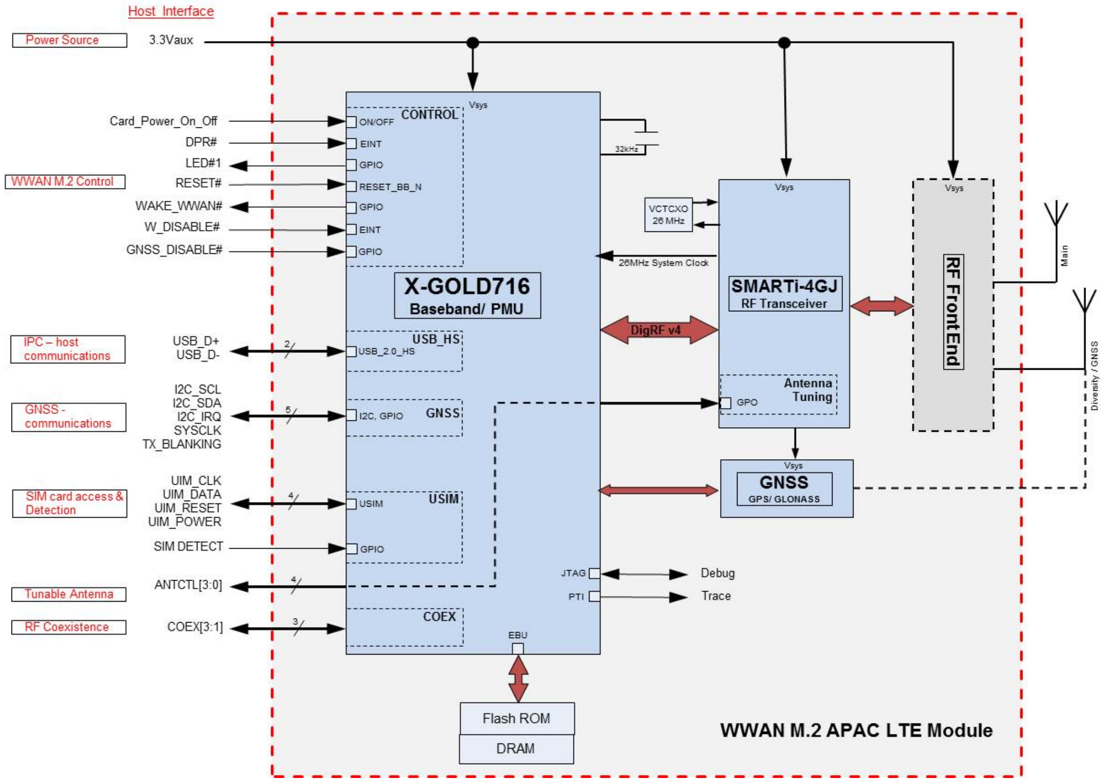

Figure 2 M.2 APAC LTE Module Block Diagram

2.2.3 M.2 LN930 Module

The M.2 LTE module is based on Intel's XMM™7160 modem platform. The M.2 LTE module is a triple-mode (2G, 3G, and 4G) 3GPP release 9 modem providing datacard functionality.

The M.2 LTE module includes support at the 75 pin application interface for M.2 Control, USB 2.0 HS, GNSS, USIM and Antenna Tuning.

A block diagram of the M.2 LTE module is shown in Figure 3.

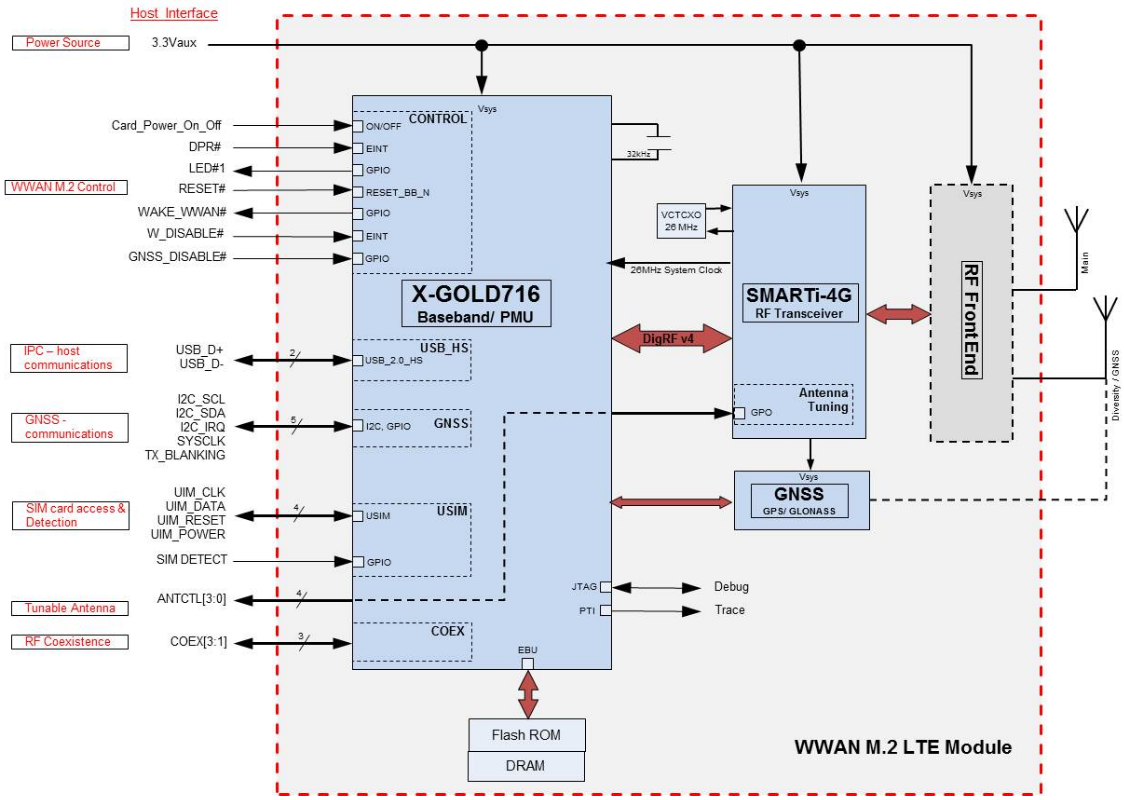

Figure 3 M.2 LTE Module Block Diagram

A more detailed interconnect diagram of the RF Engine utilized on the M.2 LTE Module is shown in Figure 4.

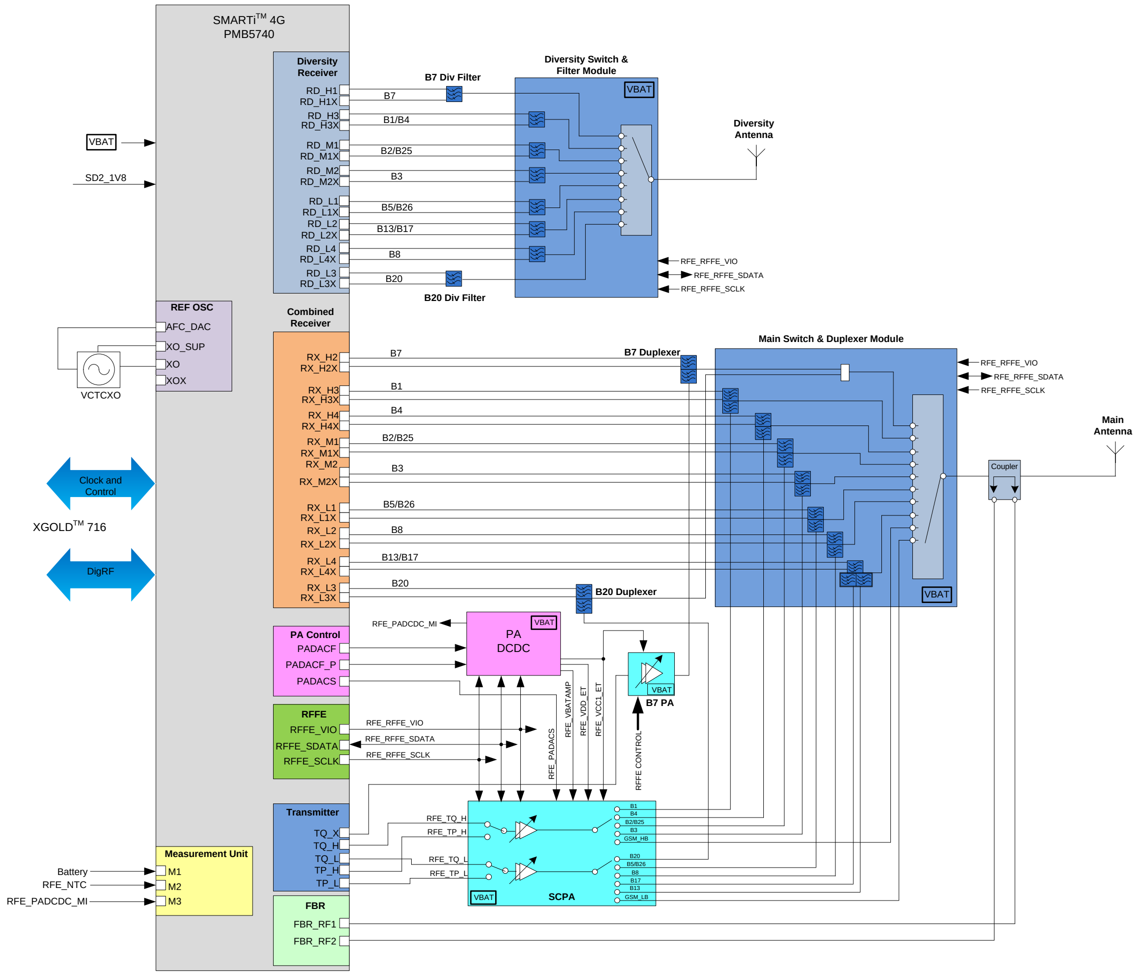

Figure 4 Detailed Interconnection of M.2 LTE Modem RF Engine

2.3 Host Interface Signals

This section describes the signals available to the host processor at the 75 pin application interface. Eight signals are eliminated by the notch on the host connector, leaving 67 usable signals. A diagram of the M.2 module identifying the 75 pin interface is shown in Figure 5.

Note that the M.2 module has all components mounted on the top side. Odd pin numbers are on the top side while even pins on the bottom side.

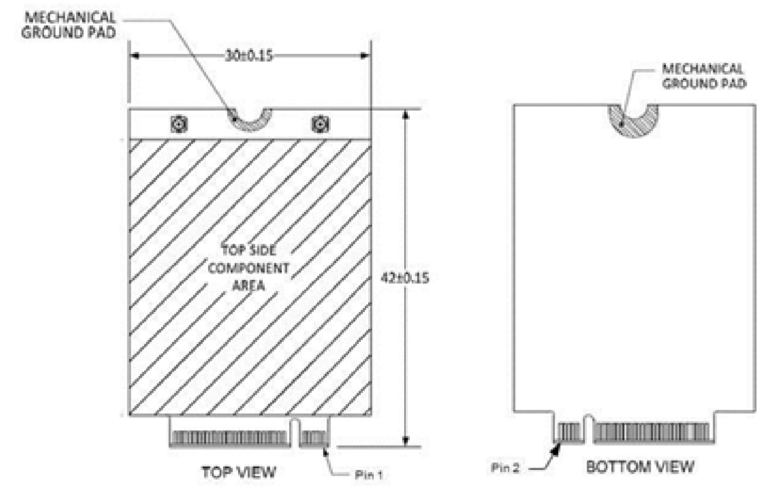

Figure 5 PCI Express M.2 Module Interface

A complete description of all interface signals available at the host interface is listed in Table 4. Some features, such as GNSS and Antenna Tuning, are not available on every M.2 module. On those modules, the signals at the application interface are not connected on the M.2 module.

Table 4 M.2 Host Interface Signals

Pin	Signal Name	I/O	Description	Supply
1	CONFIG_3	O	Presence Indication: WWAN M.2 Connects to GND internally	-
2	3.3V	P	M.2 Supply Pin 3.3 V	3.3 V
3	GND	P	Ground	-
4	3.3V	P	M.2 LTE Supply Pin 3.3 V	3.3 V
5	GND	P	Ground	-
6	FULL_CARD_POWER_OFF#	I	Control signal to power On/Off M.2.	1.8 V
7	USB D+	IO	USB 2.0 HS DPLUS Signal	
8	W_DISABLE#	I	Active low signal to Disable Radio Operation	3.3 V
9	USB D–	IO	USB 2.0 HS DMINUS Signal	

10	LED#1	O	Open Drain, active low signal used for add-in card to provide status	3.3 V
11	GND	P	Ground	-
12	SLOT KEY			
13	SLOT KEY			
14	SLOT KEY			
15	SLOT KEY			
16	SLOT KEY			
17	SLOT KEY			
18	SLOT KEY			
19	SLOT KEY			
20	AUDIO0	IO	PCM Clock (I2S_CLK)	1.8 V
21	CONFIG_0	O	Configuration Status. Presently not connected on WWAN M.2 module.	-
22	AUDIO1	I	PCM In (I2S_RX)	1.8 V
23	WAKE_WWAN#	O	Wake On WWAN Use by M.2 to wake up host.	1.8 V
24	AUDIO2	O	PCM Out (I2S_TX)	1.8 V
25	DPR	I	Dynamic Power Reduction - Body SAR control signal	1.8 V
26	GNSS_DISABLE#	I	Disable GNSS function	1.8 V
27	GND	P	Ground	-
28	AUDIO3	IO	PCM Sync (I2S_WA0)	1.8 V
29	SSIC_RxN	I	SSIC Receive N (Not Supported)	-
30	UIM-RESET	O	SIM Reset (I)	1.8 V/3.0 V
31	SSIC_RxP	I	SSIC Receive P (Not Supported)	-
32	UIM-CLK	O	SIM Clock (I)	1.8 V/3.0 V
33	GND	-	Ground	-
34	UIM-DATA	IO	SIM Data (I/O)	1.8 V/3.0 V
35	SSIC_TxN	O	SSIC Transmit N (Not Supported)	-
36	UIM-PWR	O	SIM power	1.8 V/3.0 V
37	SSIC_TxP	O	SSIC Transmit P (Not Supported)	-
38	N/C	-	Not connected internally on M.2	-
39	GND	P	Ground	-
40	I2C_SCL	IO	I2C Clock – GNSS Support	1.8 V

41	N/C	-	Not connected internally on M.2	-
42	I2C_SDA	IO	I2C Data – GNSS Support	1.8 V
43	N/C	-	Not connected internally on M.2	
44	I2C_IRQ	I	GNSS Interrupt Request – GNSS Support	1.8 V
45	GND	P	Ground	-
46	SYSCLK	O	26 MHz reference Clock output for external GNSS module	1.8 V
47	N/C	-	Not connected internally on M.2	-
48	TX_BLANKING	O	GNSS Blanking Signal used to indicate 2G Tx burst and LTE band 13 Tx burst.	1.8 V
49	N/C	-	Not connected internally on M.2	-
50	N/C	-	Not connected internally on M.2	-
51	GND	P	Ground	-
52	N/C	-	Not connected internally on M.2	-
53	N/C	-	Not connected internally on M.2	-
54	N/C	-	Not connected internally on M.2	-
55	N/C	-	Not connected internally on M.2	-
56	N/C	-	Not connected internally on M.2	-
57	GND	P	Ground	-
58	N/C	-	Not connected internally on M.2	-
59	ANTCTL0	O	RF Antenna Tuning Control Signal 0	1.8 V
60	COEX3	O	Wireless Coexistence between WWAN and WiFi/BT modules. IDC_LteDtxEnv	1.8 V
61	ANTCTL1	O	RF Antenna Tuning Control Signal 1	1.8 V
62	COEX2	I	Wireless Coexistence between WWAN and WiFi/BT modules. IDC_CwsPriority	1.8 V
63	ANTCTL2	O	RF Antenna Tuning Control Signal 2	1.8 V
64	COEX1	O	Wireless Coexistence between WWAN and WiFi/BT modules. IDC_LteFrameSync	1.8 V
65	ANTCTL3	O	RF Antenna Tuning Control Signal 3	1.8 V
66	SIM DETECT	I	SIM Card Detection (I) (low active). • Pull-up resistor on WWAN M.2 module	1.8 V
67	RESET#	I	Single control to reset WWAN	1.8 V
68	N/C	-	Not connected internally on M.2	-

69	CONFIG_1	O	Configuration Status WWAN M.2 Connects to GND internally	-
70	3.3V	P	WWAN Supply Pin 3.3 V	-
71	GND	P	Ground	-
72	3.3V	P	WWAN Supply Pin 3.3 V	-
73	GND	P	Ground	-
74	3.3V	P	WWAN Supply Pin 3.3 V	-
75	CONFIG_2	O	Configuration Status WWAN M.2 Connects to GND internally	-

3 M.2 Module Interface Details

This section provides details on the various interfaces available M.2 modules.

3.1 Interprocessor Interface (IPC)

There are two interfaces on the M.2 host interface that support interprocessor communications (ICP); however, for the WWAN M.2 modules covered by the Product Description only the USB 2.0 High-speed port will be supported.

The other ICP interface, USB Super-speed Inter-Chip (USB_SSIC), is not supported and the signals should not be connected at the host.

The host processor, connected via an ICP interface, has access to the functions of the WWAN card.

3.1.1 USB 2.0 High-Speed – IPC Interface

The USB 2.0 High-speed interface supports the following device classes: CDC-MBIM, CDC-ACM, and CDC-NCM.

The USB Controller is compliant to the USB 2.0 Specification and with the Link Power Management (LPM) Addendum. LPM introduces a new sleep state (L1) which significantly reduces the transitional latencies between the defined power states; hence, improving the responsiveness of the WWAN platform regarding connecting to the internet (Quick Connect).

- USB2.0 LPM L1 Support
- Support for OS assisted fast dormancy
- Selective Suspend support
  - Very low power when in Selective Suspend:
    - <4mw when connected to network (wake)
    - <1 mW no wake

It supports High-speed (HS, 480 MBit/s); Full-speed (FS, 12 MBit/s) transfers. Low- speed mode is **not** supported. Because there is not a separate USB-controlled voltage bus, USB functions implemented on the M.2 module are expected to report as self-powered devices

<u>General Features</u>

- In device mode : High-speed (480 MBit/s) and Full-speed (12 MBit/s)
- In host mode: High-speed (480 MBit/s), Full-speed (12 MBit/s). Low-speed mode (1.5 Mbit/s) is **not** supported.
- Support for 16 bidirectional end points and channels including the end point 0.

Table 5 USB HS Interprocessor Communications Interface

Signal Name	Description	Pin	Direction (WWAN)	Voltage Level
USB_D+	USB Data Plus	7	I, O	Per USB 2.0 specification
USB_D–	USB Data Minus	9	I, O	

3.1.2 USB Super-speed IC (Reserved)

The USB Super-speed IC (USB SSIC) solution is not supported by the WWAN M.2 modules presented in this Product Description. It is set aside for future development. These signals should be left un-connected on the host.

Table 6 USB SSIC – ICP Interface

Signal Name	Description	Pin	Direction (WWAN)	Operating Voltage Range
SSIC_RXN	USB SSIC Receiver Signal N	29	O	Per SSIC specification
SSIC_RXP	USB SSIC Receiver Signal P	31	O	
SSIC_TXN	USB SSIC Transmitter Signal N	35	I	
SSIC_TXP	USB SSIC Transmitter Signal P	37	I	

3.2 (U)SIM Interface

The USIM interface is compatible with the ISO 7816-3 IC Card standard on the issues required by the GSM 11.12 and GSM 11.18 standard.

Both 1.8 V and 3 V SIM Cards are supported.

A few comments on the SIM_DETECT signal

1. An external pull-up resistor is connected to SIM_DETECT on the WWAN M.2 module.
2. When a SIM is inserted, SIM_DETECT will be high.
3. When a SIM is removed or not present, SIM_DETECT will be low.
4. The host does not need to drive this signal. It can be tri-stated.

Table 7 (U)SIM Interface Signals

Signal Name	Description	Pin	Direction (WWAN)	Voltage Level
UIM_CLK	Clock SIM Card	32	O	1.8 V/3.0 V
UIM_DATA	Input/ Output SIM Card	34	I, O	1.8 V/3.0 V
UIM_RESET	Reset signal for SIM card	30	O	1.8 V/3.0 V
USIM_PWR	1.8 V/3 V Supply for SIM Card	36	O	1.8 V/3.0 V
SIM Detect	SIM Card Detection	66	I	1.8 V

3.2.1 SIM Design Recommendations

The following design guidelines are recommended for the SIM card socket mounted on the host system:

- Length of the traces UIM_CLK, UIM_DATA, and UIM_RESET should not exceed 10 cm.
- UIM_DATA is a sensitive open-drain bi-directional signal. It should not be mounted beside the UIM_CLK signal for long distances. It is recommended to place the UIM_RST trace between UIM_DATA and UIM_CLK to provide isolation. If the traces are run a long distance, surround the UIM_DATA with ground to shield from system noise and UIM_CLK.
- The rise time for UIM_DATA should not exceed 1 µs per the 3GPP specification. High input capacitance may increase rise time and lead to certification failure.
  - Keep UIM traces with low capacitance between each other and to GND
  - An ESD component with high capacitance may increase rise time.

- The pull-up current cannot be increased to speed up rise time, because the pull-up current must not exceed 1 mA including any crosstalk.
- Pull-up current is defined by the 4.7 kΩ pull-up resistor (to USIM_PWR) on the WWAN M.2 module, plus 200 µA from the baseband chip is approximately 0.8 mA.

- Place a decoupling capacitor close to the SIM card socket.

3.3 GNSS Interface

Some M.2 modules incorporate GPS and GLONASS receivers with aGPS to support Global Positioning.

For M.2 modules that feature GNSS support, see Table 1, the M.2 module incorporates the CG1960 Single-Chip GNSS Device, which is a complete receiver for simultaneous reception and processing of both GPS and GLONASS signals. It includes LNA, mixer, bandpass filter, VCO, ALC, fractional-N frequency synthesizer, digital tunable filters, PGA stage, and multi-bit ADCs. A UART interface is used by the X-GOLD™ Communications Processor on the M.2 module to control the GNSS device. The solution offers best-in-class acquisition and tracking sensitivity, TFF and accuracy.

The GNSS device supports several different power management modes which gives the lowest possible energy usage per fix. The pre-calculated location data will be sent over the USB host interface. In addition, the M.2 will produce GPS data when the system is in sleep mode via an I2C interface to allow for applications to be available in low power modes.

GNSS General Features

- Autonomous GPS / GLONASS
- Assisted GPS Using SUPL 1.0/2.0
  - MS Assisted positioning (SET / NET Initiated)
  - MS Based positioning (SET / NET Initiated)
- SUPL 2.0 Feature Sets
  - Version Negotiation
  - Periodic Triggers
  - Emergency Positioning
  - Area Event Triggers (SET Init & NET Init)
  - Application ID
  - Enhanced Cell Id
  - Multiple Location IDs
  - Session Info Query
  - Location Transfer to 3rd Party
  - Notification Verification Based on Current Location
  - Location Request to another SET

A diagram of the GNSS connections on the M.2 module is shown in Figure 6. This diagram identifies the signals between the X-GOLD™ baseband and GNSS devices along with the USB and GNSS signals available to the host at the card interface.

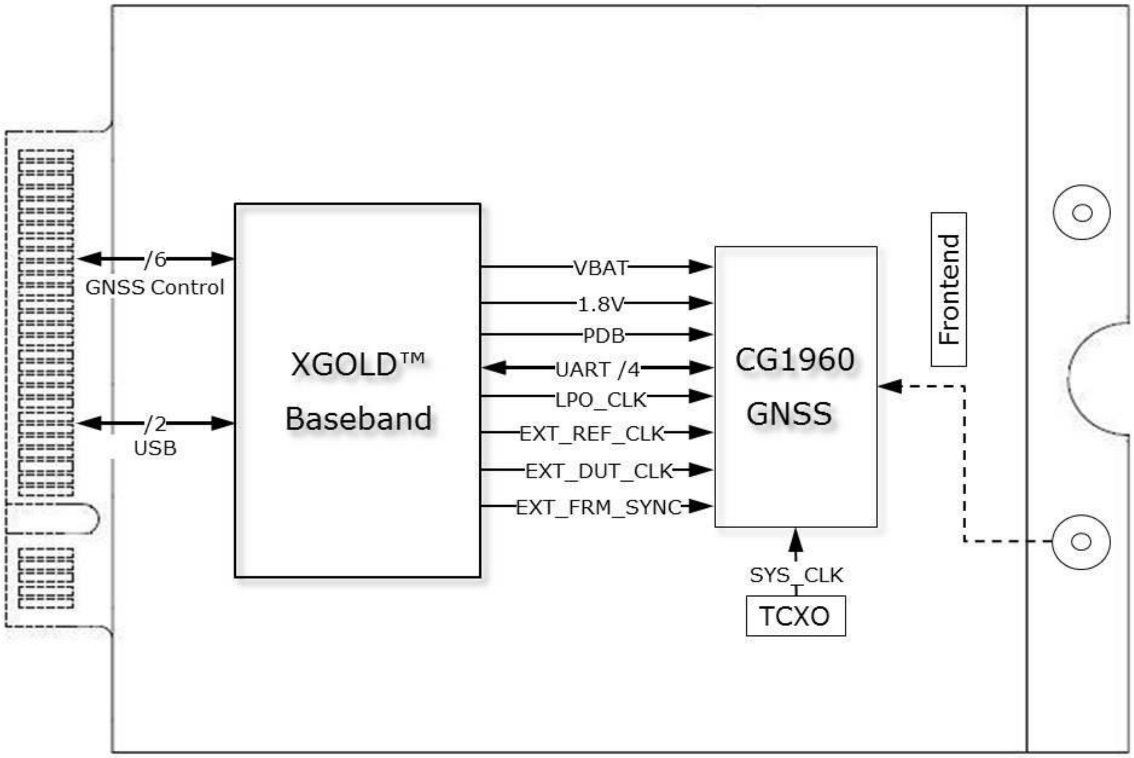

Figure 6 GNSS Connections and Interface

A description of the signals between the X-GOLD™ baseband and the CG1960 interface are defined in Table 8.

Table 8 X-GOLD™ Baseband to GNSS Interface Signals

Signal	Description
VBAT	Battery Supply
1.8V	1.8 V Supply provided from X-GOLD™ Baseband
UART	The data and control I/F between the X-GOLD™ baseband and the GNSS device is over a 4 wire UART interface which include CTS/RTS handshaking.
PDB	X-GOLD™ baseband uses this signal to control Power-on/reset of the GNSS device
LPO_CLK	X-GOLD™ baseband provides a permanently active 32 kHz clock to the GNSS device
EXT_REF_CLK	X-GOLD™ baseband provides a 26 MHz clock to the GNSS device for frequency aiding.
EXT_DUT_CLK	X-GOLD™ baseband provides this signal to notify the GNSS device of that GSM Tx activity (PA Blanking)
EXT_FRM_SYNC	X-GOLD™ baseband provides a strobe signal to the GNSS device to allow fine time assistance based on 3GPP cell timing.

The GNSS signals available to the host at the WWAN module interface to support GNSS operation are shown in Table 9.

Table 9 GNSS Module Interface Signals

Signal Name	Description	Pin	Direction (WWAN)	Voltage Level
I2C_SCL	I2C Clock	40	I, O	1.8 V
I2C_SDA	I2C Data	42	I, O	1.8 V
I2C_IRQ	I2C IRQ - Interrupt signal	44	I	1.8 V
SYSCLK	Synchronization Clock	46	I	1.8 V
TX_BLANKING	TX Blanking – Active High when M.2 is transmitting.	48	O	1.8 V
GNSS_DISABLE#	GNSS Disable • High: GNSS function is determine by AT command. • Low: GNSS function is disabled. • GNSS_DISABLE# pin has a pull-up resistor on the WWAN M.2 module	26	I	1.8 V

3.4 System Control Interface

The system control interface is used to control the power-up and reset of the WWAN module. There are additional control signals to disable the radio, drive an LED as a status indicator, an output to wake the host processor, and an input for body SAR.

3.4.1 Power On & Reset

The host processor has two signals that can be used to power on and reset the modem. Powering off the modem is accomplished through an AT command.

Table 10 Power-on & Reset Signals

Signal Name	Description	Pin	Direction (WWAN)	Voltage Level
FULL_CARD_POWER_ON_OFF	**Modem power on:** For Tablet based designs only; this signal is used for power on-off control of X-GOLD™ Baseband IC.WWAN M.2 module • Logic Low: M.2 Off • Logic High: WWAN M.2 Power On This pin has an internal pull-down resistor. **Ultrabook designs:** Ultrabook host should deliver a 1.8V signal to turn on the module. If 1.8V is not feasible, recommend using a 47kΩ series resistor connected to 3.3V.	6	I	1.8 V
RESET#	Reset the WWAN system. This signal is used to reset the module. This signal is part of the **modem rigorous power-off** procedure. The host will first assert this signal, followed by assertion of: • FULL_CARD_POWER_OFF# signal (for **Tablet**) • Switch off 3.3V regulator (for **Ultrabook**) Asserting RESET first is to trigger PMU internal state machine to run shutdown sequences e.g. for SIM and external memory controller (EMIC), before switching off power supplies. • Asynchronous, active low signal. When active, the WWAN M.2 module will be placed in a power–on reset condition. RESET# pin has a pull-up resistor on the WWAN M.2 module	67	I	1.8 V

3.4.2 Host Radio Disable Operation

An additional control signal is used to disable the radio on the module.

Signal W_DISABLE# is provided to allow users to disable, via a system-provided switch, the add-in card's radio operation in order to meet public safety regulations or when otherwise desired. Implementation of this signal is required for systems and all add—in cards that implement radio frequency capabilities.

The W_DISABLE1 signal is an active low signal that when driven low by the system shall disable radio operation. The assertion and de-assertion of the W_DISABLE# signal is asynchronous to any system clock. All transients resulting from mechanical switches need to be de-bounced by the host system and no further signal conditioning will be required. When the W_DISABLE# signal is asserted, all radios attached to the add-in card shall be disabled. When the W_DISABLE# is not asserted or in a high impedance state, the radio may transmit if not disabled by other means such as software.

The operation of the W_DISABLE# Signal is:

Enable, ON (3.3V): The radio transmitter is to be made capable of transmitting.

Disable, OFF (low): The radio transmitter(s) is to be made incapable of transmitting.

Standard TTL signaling levels shall be used making it compatible with 1.8 V and 3.3 V signaling.

W_DISABLE# pin has a pull-up resistor on the M.2 module.

Table 11 Radio Disable Signal

Signal Name	Detailed Description	Pin	Direction (WWAN)	Voltage Level
W_DISABLE#	**Disable Radio.** This active low signal allows the host to disable the M.2 radio operation in order to meet public safety regulations or when otherwise desired. • Logic Low: M.2 Off • Logic High: function is determined by Software (AT Command). If this pin is left un-connected, functionality is controlled by software. Care should be taken not to activate this pin unless there is a critical failure and all other methods of regaining control and/or communication with the M.2 module have failed.	8	I	Compatible with 1.8 V/3.3 V

Standard TTL signaling levels shall be used.

Table 12 Host Radio Disable Interface (W_DISABLE#)

Requirement	Detailed Description
Radio disable duration	On reception of a HW or SW disable signal, the WWAN module will initiate within one **second** the mandatory cellular procedures (which are dependent on current state) for disconnecting from the cellular network. The time taken to complete the procedures will be dependent on external factors including but not limited to: 3G/4GPP specifications, network implementation, radio conditions, etc. Once those procedures are complete, the WWAN module will switch off the RF.
Radio enable duration	On reception of a hardware or software enable signal the WWAN module will initiate within **one second** the mandatory cellular procedures for connecting to the cellular network.
Radio enable during selective suspend	If radio is disabled due to W_DISABLE# assertion and WWAN module is in selective suspend, then W_DISABLE# de-assertion shall be detected by WWAN module and the module shall initiate exit from selective suspend.

3.4.3 LED Interface – Status Indicator

An LED will be used to provide status indications to users via system provided indicators.

LED#1 (pin 10) is an active low output signal intended to drive system-mounted LED indicators. These signals shall be capable of sinking to ground a minimum of 9.0 mA at up to a maximum VOL of 400 mV.

Table 13 LED#1 Signal

Signal Name	Detailed Description	Pin	Direction (WWAN)	Voltage Level
LED#1	LED Status Indicator	10	O (OD)	3.3 V

Figure 7 is an example of how an LED indicator is typically connected in a platform/system using 3.3 V. The series resistor can be adjusted to obtain the desired brightness.

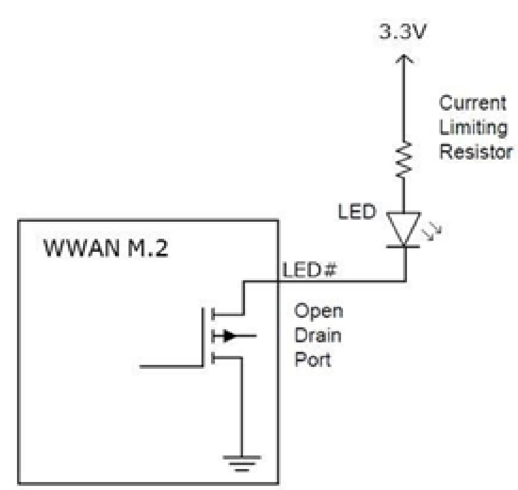

Figure 7 Typical LED Connection

The indication protocol for the LED is shown in Table 14.

Table 14 LED State Indicator

State	Definition	Characteristics	WWAN
OFF	The LED is emitting no	-	Not
ON	The LED is emitting light in a stable non-flashing state	-	Powered registered but not transmitting or receiving

3.4.4 Wake on WWAN Signal

An output signal is available to wake the host system, WAKE_WWAN#. This is an active low, open-drain output.

This output requires a pull-up resistor on the host system.

Table 15 Wake on WWAN Signal

Signal Name	Detailed Description	Pin	Direction (WWAN)	Voltage Level
WAKE_WWAN#	Used by M.2 module to wake the host. Active Low, Open Drain output	23	O (OD)	3.0 V

3.4.5 Dynamic Power Reduction

With the arrival of Tablets and Ultrabook™ platforms where the antenna is in the base of the unit, there is a significant issue passing Specific Absorption rate (SAR) requirements for certification.

The WWAN M.2 module has the ability to configure RF TX power levels based on proximity sensor input from the host.
A WWAN M.2 power control API is available to the host to dynamically reduce RF transmit power levels of the WWAN module based on proximity sensor input from the host.
The DPR# (Dynamic Power Reduction) signal is available on the host interface to assist in meeting regulatory SAR (Specific Absorption Rate) requirements for RF exposure. The signal is provided by a host system proximity sensor to the WWAN module to provide an input trigger causing a reduction in the radio transmit output power.
In conjunction with the DPR signal, a full power control API is available to the host to adjust the RF transmit power level of the WWAN module.
DPR pin has a pull-up resistor on the WWAN M.2 module.

Table 16 DPR# / SAR Support Signal

Signal Name	Detailed Description	Pin	Direction (WWAN)	Voltage Level
DPR#	Dynamic Power reduction.	25	I	1.8 V

3.5 Tunable Antenna Control Interface

In notebook platforms, since the WWAN antennas are usually located on the top of the lid, there is a long RF mini-coax cable that can be up to 60 cm long between the antenna and WWAN module, it is preferred to use switches/tunable components directly on the antenna for antenna band switching/tuning to improve efficiency.
On select WWAN M.2 modules, four (4) GPOs are available on the host interface that can be connected to an external antenna switch, to load the antenna with different impedances, configuring the different frequency responses for the main antenna. A sample block diagram depicting the antenna control signal connections to the antenna switch is shown in Figure 8.

Intel’s current antenna control solution offers an open loop control solution. The WWAN M.2 modem expects the AP to provide the antenna profile detection and through a pre-defined API, notify the WWAN M.2 modem with the correct antenna profile. The WWAN M.2 modem then applies the proper antenna profile data accordingly.

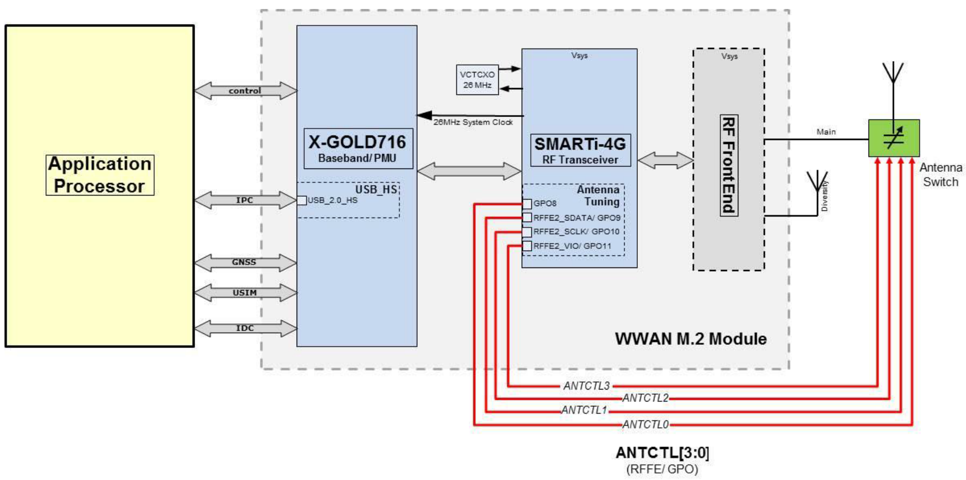

Figure 8 Antenna Control – Connections Detail

The electrical specification for the antenna control GPIOs are shown in Table 17.

Table 17 Tunable Antenna Control Signals

Signal Name	Description	Smarti™ 4G Signal	Pin	Direction (WWAN)	Voltage Level
ANTCTL0	Antenna Control 0	GPO8	59	O	1.8V
ANTCTL1	Antenna Control 1	RFFE2_SDATA/ GPO9	61	O	1.8V
ANTCTL2	Antenna Control 2	RFFE2_SCLK/ GPO10	63	O	1.8V
ANTCTL3	Antenna Control 3	RFFE2_VIO/ GPO11	65	O	1.8V

3.6 In-Device Coexistence Interface

As more and more radios are added to PC Ultrabook™ and tablet platforms, the sources RF interference increases significantly as multiple radios will have overlapping transmissions and receptions. This problem will increase further as overlapping bands continue to be rolled out; WIFI, BT, WWAN will all use overlapping band from 2300 MHz to 2600 MHz.

In-Device Coexistence is a feature which improves the user experience and maximizes throughput and Quality of Service of connectivity systems (WLAN, BT and GNSS) when these radios are simultaneously running with the WWAN M.2 LTE modem.

A diagram of the In-Device Coexistence architecture is shown in Figure 6.

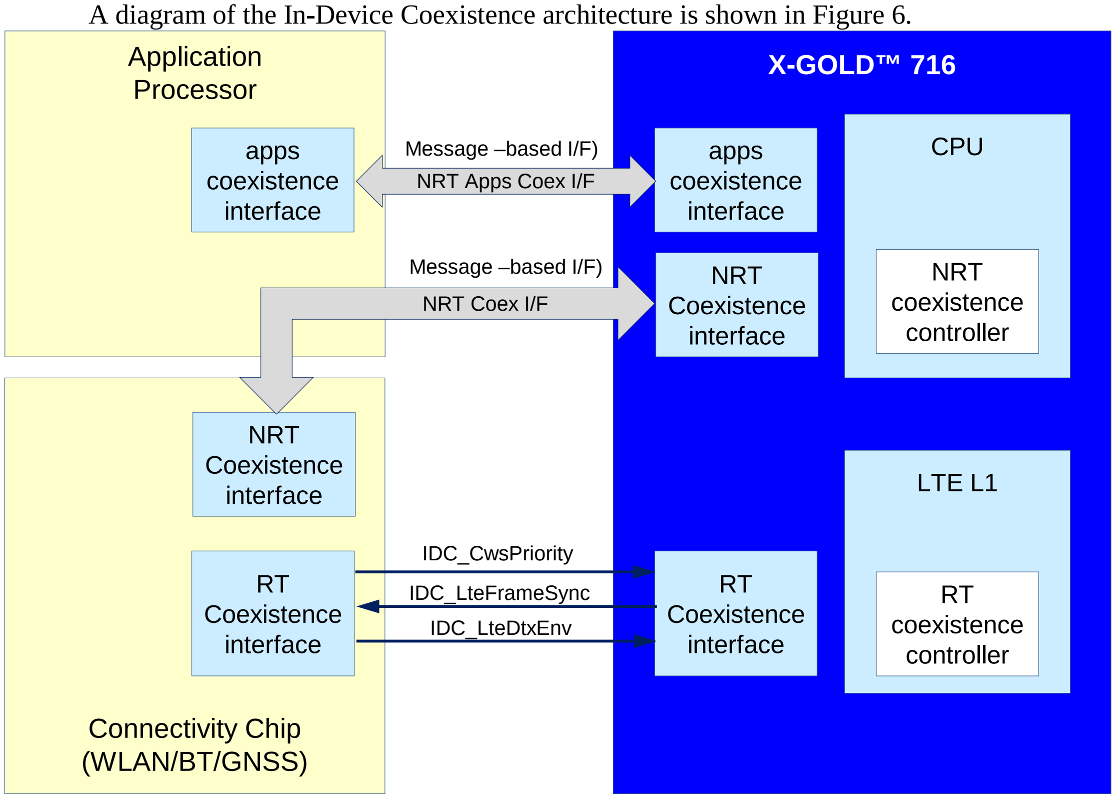

Figure 9 In-Device Coexistence Architecture

Seamless Co-running

In-Device-Coexistence primarily aims at avoiding interference between radio systems to allow seamless co-running where LTE and WLAN/BT/GNSS ensuring their maximum throughput and performance. To do so, a Non Real Time (NRT) coexistence controller is implemented on the ARM™ CPU. The NRT coexistence controller centralizes LTE, WLAN, BT and GNSS information and performs interference avoidance mechanisms, selecting interference-safe frequency configurations whenever possible. The NRT coexistence controller is also in charge of enabling some Real Time (RT) coexistence mechanisms when

NRT mechanisms are not sufficient to guarantee seamless co-running of LTE and connectivity systems (WLAN, BT, and GNSS).

Inter-system Synchronization

For the cases where co-running of LTE and connectivity systems cannot be achieved, a Real Time (RT) coexistence controller is implemented in the LTE Layer-1 subsystem. The RT coexistence controller is in control of the RT coexistence interface, which is exposed to the connectivity chip. The RT coexistence controller exploits real time information received from the LTE Layer-1 subsystem and from the connectivity chip to coordinate LTE and connectivity "in the air" activities. The coordination function protects LTE traffic while optimizing the throughput and availability of WLAN/BT/GNSS. When operating in this mode, the connectivity systems have reduced capability since they access the medium when LTE is inactive, or when their respective operations do not impact each other significantly.

The Non Real-Time mechanism implements a messaging based interface, formatted as AT commands that are passed to the AP host over the IPC interface (USB). A simple piece of SW residing on the AP host will tunnel the Non Real-Time messages between the BT/WLAN device and M.2 module, translate AT commands to/from the BT/WLAN driver commands, and maintain the states of the BT/ WLAN and M.2 LTE modem. The host software will also be responsible for initializing the Real-Time mechanism.

The Real-Time mechanism consists of 3 GPIO signals which allow the synchronization of multiple TX and RX events. The signals to support real Time coexistence are listed in Table 18.

If the coexistence signals are not used by the host system, they should not be connected.

Table 18 Coexistence – Hardware Synchronization Signals

Signal Name	Description	Pin	Direction (WWAN)	Voltage Level
COEX3	**IDC_LteDtxEnv -** Synchronous signal indicating LTE UL gap. Envelop signal with edges occurring 1ms before in-the-air gap (raising and falling edges) RT arbiter indicates to connectivity cores when there is no LTE Tx (Envelope)	60	O	1.8 V
COEX2	**IDC _CwsPriority -** 0 : Low priority / 1 : high priority CWS Indicates if the coming activity is high priority	62	I	1.8 V

COEX1	**IDC_LteFrameSync -** Synchronous signal indicating LTE frame start. Indicates LTE frame start to BT/WLAN device. Can be used by BT to synch up periodic activity with LTE timing	64	O	1.8 V

3.7 Power Supply Interface

The M.2 modules require the host to provide the 3.3 V power source. The voltage source is expected to be available during the system's stand-by/suspend state to support wake event processing on the communications card.

The 3.3 V power and ground pins are listed in Table 19.

Section 8, Power Delivery Requirements, provides electrical requirements for the power supply and I/O signals.

Table 19 Power & Ground Signals

Power Pins	Description
2, 4, 70, 72, 74	3.3 V Supply
3, 5, 11, 27, 33, 39, 45, 51, 57, 71, 73	Ground

3.8 Trace & Debug Interface

The USB port on the M.2 module will be used to support system tracing of the Protocol stack. The USB HS and USB_SSIC ports can be used for software download, tracing, and manufacturing testing

The JTAG & MIPI PTI1 ports are accessible on the module to support system debug. A temporary cable assembly over flat flex should be assembled on bottom of the module and lead out of the final product. The cable would not be mounted on the final product.

3.9 Configuration Pins

There are 4 configuration pins on the M.2 module to assist the host identifying the presence of an Add-In card in the socket.
On the M.2 module, pins CONFIG_0..3 are configured as shown in Table 20.
All configuration pins can be read and decoded by the host platform to recognize the indicated module configuration and host interface supported. On the host side, each of the CONFIG_0..3 signals needs to be fitted with a pull-up resistor.

Table 20 M.2 Configuration Pins

Signal Name	Description	Pin	Direction (WWAN)	Voltage Level
CONFIG_0	This signal is not connected to the WWAN M.2 module.	21	O	-
CONFIG_1	Tied to Ground internally on the WWAN M.2 module.	69	O	0 V
CONFIG_2	Tied to Ground internally on the WWAN M.2 module.	75	O	0 V
CONFIG_3	Tied to Ground internally on the WWAN M.2 module.	1	O	0 V

3.10 Audio Pins (Reserved)

There are 4 signals on the host interface that are reserved to support a digital audio interface. This is for future development, all existing WWAN M.2 modules do not support audio; **therefore, these signals should be left unconnected at the host to avoid any contention**.

Table 21 Audio Signals (Future development)

Signal Name	Description	Pin	Direction (WWAN)	Voltage Level
AUDIO0	PCM Clock (I2S_CLK)	20	IO	1.8 V
AUDIO1	PCM In (I2S_RX)	22	I	1.8 V

AUDIO2	PCM Out (I2S_ TX)	24	O	1.8 V
AUDIO3	PCM Sync (I2S_WA0)	28	IO	1.8 V

3.11 No Connect Pins

The M.2 has several No Connect pins. The pins are not connected on the M.2 module.

Table 22 No Connect Pins

Pins	Description
38, 41, 43, 47, 49, 50, 52, 53, 54, 55, 56, 58, 68	No Connect Pins
12, 13, 14, 15, 16, 17, 18, 19	Slot key

3.12 Antenna Interface

The M.2 module has space for six antenna connectors; yet, as a minimum, only two will be populated to support a main Rx/Tx antenna and a secondary antenna that will be multiplexed between the Diversity receiver and GPS receiver (if applicable). Further details on the antenna connector assignment can be found in Section 11.3.

The antenna signals are not available at the host interface but have their own connectors. A diagram on the M.2 module with the location of the RF connectors appears in Figure 10.

Table 23 Antenna Requirements

Requirement	Detailed Description
Connection to module	The connector of WWAN antenna cable is I-PEX MHF4 or equivalent
Multi-band single antenna	Single antenna has to support all bands of WWAN module specified in the Product Features.
Rx Diversity antenna	Diversity antenna has to support all bands WWAN module specified in the Product Features in addition GPS/GLONAAS frequencies.
GPS Antenna	The GPS antenna will share the Diversity antenna connector.

Figure 10 RF Antenna – Coaxial Connector Location

4 Development Tools

Intel Mobile Communications provides a carrier development board to facilitate system test and verification of the M.2 module. In addition, a set of comprehensive tools to enable rapid integration and customization of the M.2 software is provided.

The hardware and software tools for M.2 development are summarized below.

4.1 Carrier Board

The M.2 Carrier Board, shown in Figure 11, is Intel Mobile Communications hardware platform to facilitate the test and verification on the M.2 module. Once the M.2 module is mounted on the Carrier board, the user has access to all necessary interfaces on the module (host interface signals, debug and trace, and antenna) allowing full system test, debugging, and diagnostics. The carrier board with a mounted WWAN M.2 module is shown in Figure 11. Carrier Board.

Note: The Main and Diversity antenna locations have been swapped on the FIH7160 PR3.2 and earlier modules.

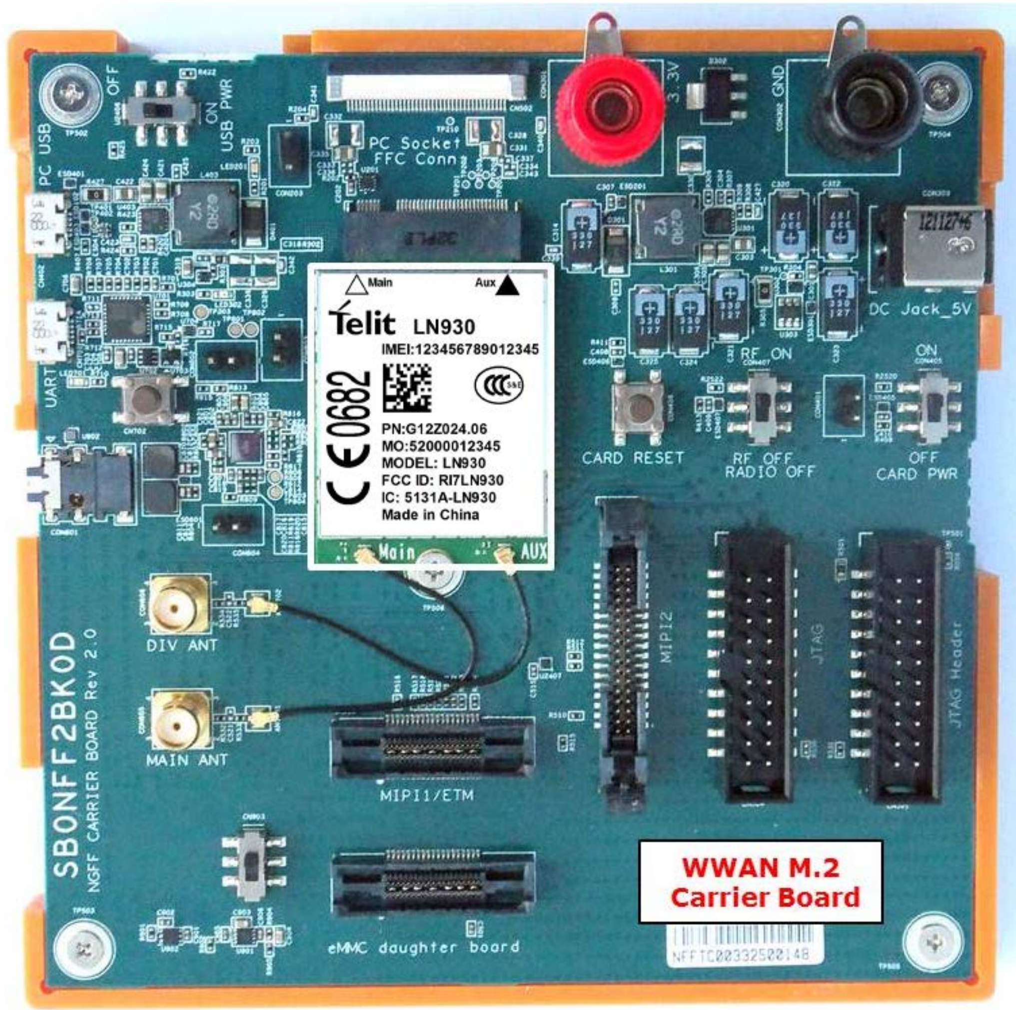

Figure 11 M.2 Carrier Board

4.1.1 FlashTool

Intel Mobile Communications provides a utility program called FlashTool for downloading a binary image into the Flash memory of the M.2 module. The USB-HS port or USIF on the platform is used for connection to a PC via a USB cable for flashing.

FlashTool is a Win32/64 application built on top of the dynamic link library, Download.DLL.

4.1.2 PhoneTool

PhoneTool is a development tool built on top of the so-called “production test dll, DWDIO.dll”. PhoneTool can be used to fine tune the parameters of:

- Audio configuration and settings (if enabled on M.2 module)
- NV (Non-Volatile) memory
- RF power ramp
- Security data IMEI
- SIM
- Real Time Clock

It also includes interfaces for:

- AT Terminal for sending and receiving AT commands.
- DWDIO interface for manual access to the production test dll DWDIO.dll.
- Generic Test Interface (GTI) for RF calibration.

4.1.3 System Trace Tool

System Trace Tool (STT) allows capturing trace sub-streams from different sources on the platform in one combined stream.

Depending on the trace interface bandwidth, the combined data stream can be sent either over one of the standard communication interfaces (e.g. USB) or over a dedicated high-speed MIPI trace interface.

Captured trace data includes standard 3GPP IPC messages, print statements inserted by developers in the code, error messages, and core dump (crash) information. The actual decoding of the trace data is done by pluggable decoder libraries, DLL’s and scripts, which are specific to the version of the mobile station software from which the trace is captured.

The STT application has a GUI (Graphical User Interface) which provides an easy to use graphical interface to view, search and analyze trace data. It supports advanced message filtering runs on all Microsoft Windows® platforms.

STT will become the only tool for trace analysis in the future, the legacy trace tools, Mobile Analyser and Artemis, will be continue to be supported for the 2G/3G WWAN M.2 HSPA+ module.

4.1.4 RF Calibration

XMMCalTool is a utility program that can be used for RF calibration. XMMCalTool supports the following features:

- Optimized calibration
- 3G TX closed loop power control
- Parallel calibration 2G low/high band
- Non-signaling verification
- Industry leading fast sequenced test concept
- Supports parallel RX and TX verification

- Proven Single-Ended BER for faster BER
- < 4 sec/per channel for 3G fast verification (BER, RSSI, TX, ILPC)

Tester supported: R&S CMU200, CMW500, and Agilent 8960

4.1.5 Noise Profiling Scan Tool

M.2 modules are marketed for use on Tablet, Ultrabook, and Laptop devices. OEM vendors routinely offer multiple hardware configurations for the same base model, with different processor speed, drive type, or display type, etc. Each configuration has a different Radio Frequency emission profile with the possibility of introducing new interference sources to a modem module.

The Noise Profiling Tool will measure, record down & plot graph of the RF noise level present on each RX channel. This SW tool will switch on receiver port and sweep all applicable RX channels on each band and each technology (WiFi, Bluetooth, GPS, and GLONASS). This will allow OEM vendors to quickly know the noise jamming profile to the modem module plugged in their devices.

5 Windows Software Components

The following section describes the system architecture of Inter-Processor Communication on a WWAN M.2 module when connected to a Microsoft Windows® based Host OS Windows® 7, Windows® 8.x.

The software components of a WWAN M.2 module running Windows® 7 and Windows® 8 are depicted in Figure 12 and Figure 13 respectively.

In the Windows® 7 architecture:

- The Windows® 7 driver interfaces with the WWAN M.2 modem using a virtual terminal connection over CDC-ECM.
- A Third party connection manager utilized
- Independent Hardware Vendor (IHV) provided MBIM driver

In the Windows® 8 architecture:

- Microsoft requirements:
    - MBIM interfaces
    - User Mode Driver Framework (UMDF) driver for GNSS, and Firmware Update, Carrier Switching application.
    - RTD3 support

For all Windows platforms:

- The WWAN M.2 module is exposed as a composite device
- GNSS will be supported through a serial interface
- When mobile broadband is disabled, GNSS will still be available.
- The mobile network adapter driver will interface to the modem software through the MBIM interface.
- All Intel specific features will be supported through MBIM.
- The connection manager provided with Win 8 OS and above will be used. For
- Win 7, the IHV provided connection manager is used.
- There will be an application layer to hide the differences in the mobile broadband API between Win 7 and Win 8.

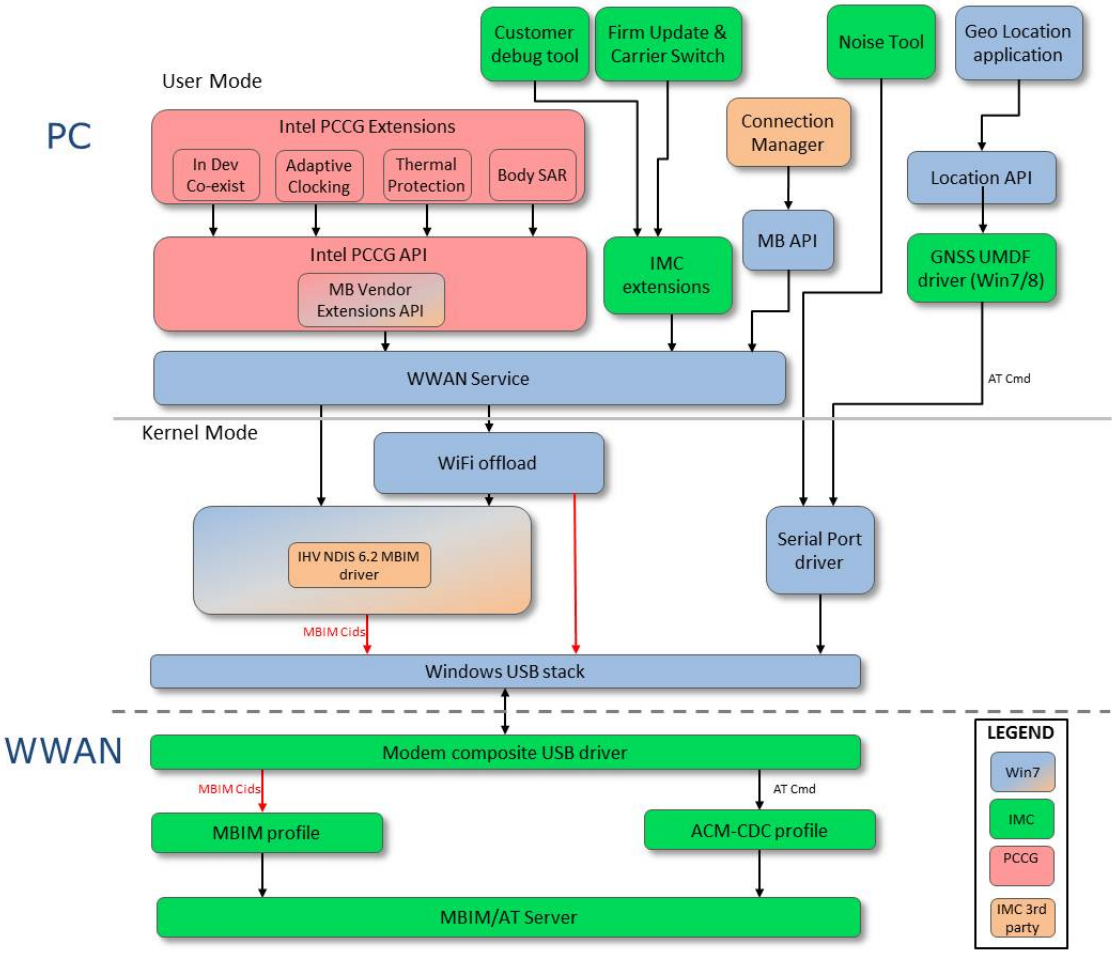

Figure 12 Windows 7 Software Architecture

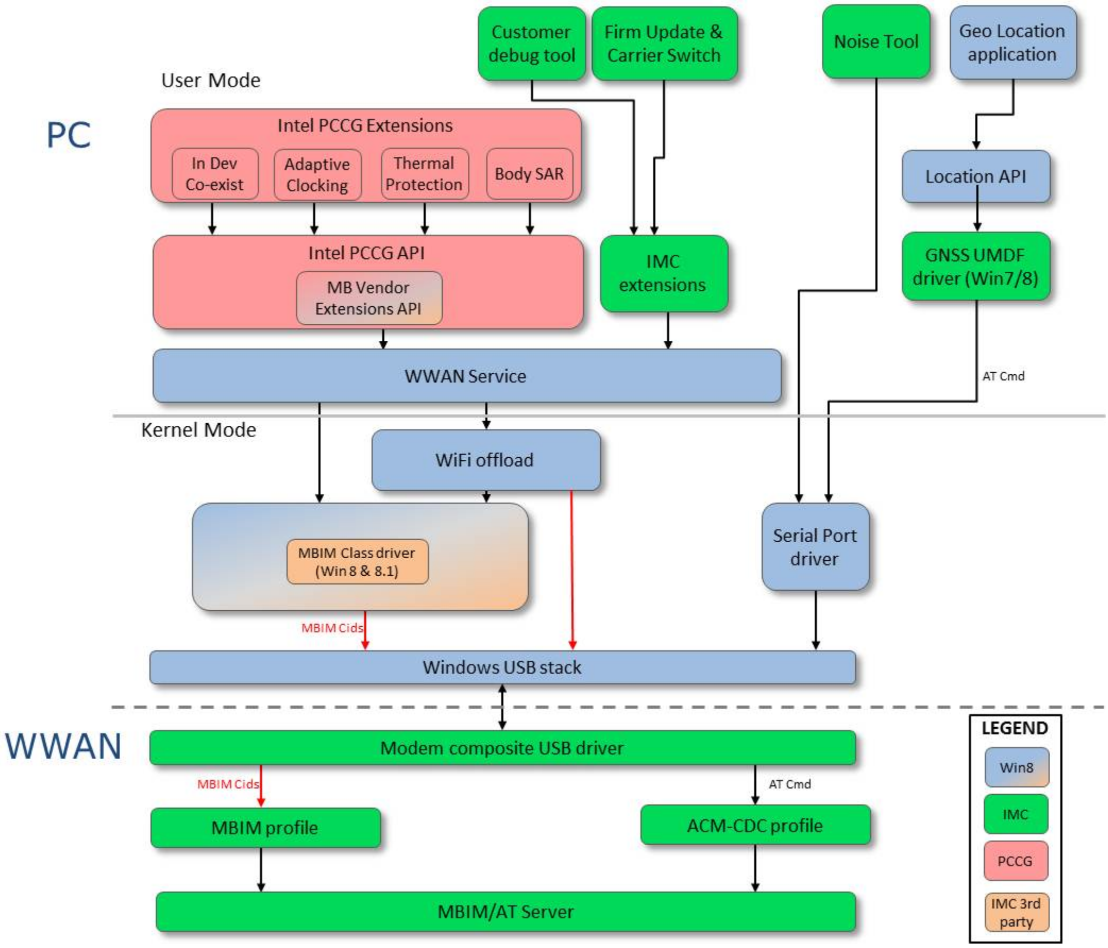

Figure 13 Windows 8 Software Architecture

5.1 MBIM Toolkit

5.1.1 Windows® 7 MBIM driver

In order to support both Windows® 8 and Windows® 7 (for corporate legacy applications), with a single modem architecture, IMC will provide a kernel level driver implementing the Mobile Broadband Interface Model. The driver is WHQL certified for Windows® 7.

5.1.2 GNSS UMDF driver for Windows® 7 and Windows® 8

IMC provides a GNSS "User mode" driver to enable GNSS Applications executing on Windows PC/Tablet to communicate to the GNSS device located on the M.2 module. The driver communicates to Modem module via AT commands over an ACM-CDC USB channel.

5.1.3 M.2 module Firmware Update

This is a “user friendly” Windows GUI application enabling the consumer, whose Ultrabook or tablet is hosting an Intel M.2 module, to update the firmware on WWAN module by executing a graphical application based on .NET4 framework. The same application runs on both Windows® 7 and Windows® 8 environments and its look & feel can be customized if required.

This same application is used to upgrade the standard image flashed at the factory with one that better fits the local Carrier. When a new SIM is inserted, the application will detect the inserted SIM does not match the WWAN device firmware. It will then allow the user to select and update the WWAN firmware with a suitable image reflecting the local network of the Carrier.

5.1.4 End User Trace Tool

This is a Windows® 8 application allows a M.2 end user to collect debugging information under guidance of a Customer Support operator. The log file can be sent to a Technical support center and fed into an analysis tool, such as Intel’s Mobile Analyzer application, to diagnose potential problems found in the field after module deployment.

6 Linux/Chrome Software Architecture

The following section describes the system architecture of Inter-Processor Communication on a M.2 module when connected to a Linux based Host OS (Android, Chrome, and Ubuntu). The description is only concerned with the HS-USB port which is the only available functional interprocessor communications (IPC) interface at run-time and takes into account only the AT control plane and IP packets data connection. Audio packet exchange is outside the scope of the current version of M.2.

6.1 Overview

Figure 14 illustrates the architecture of the IPC and its components.

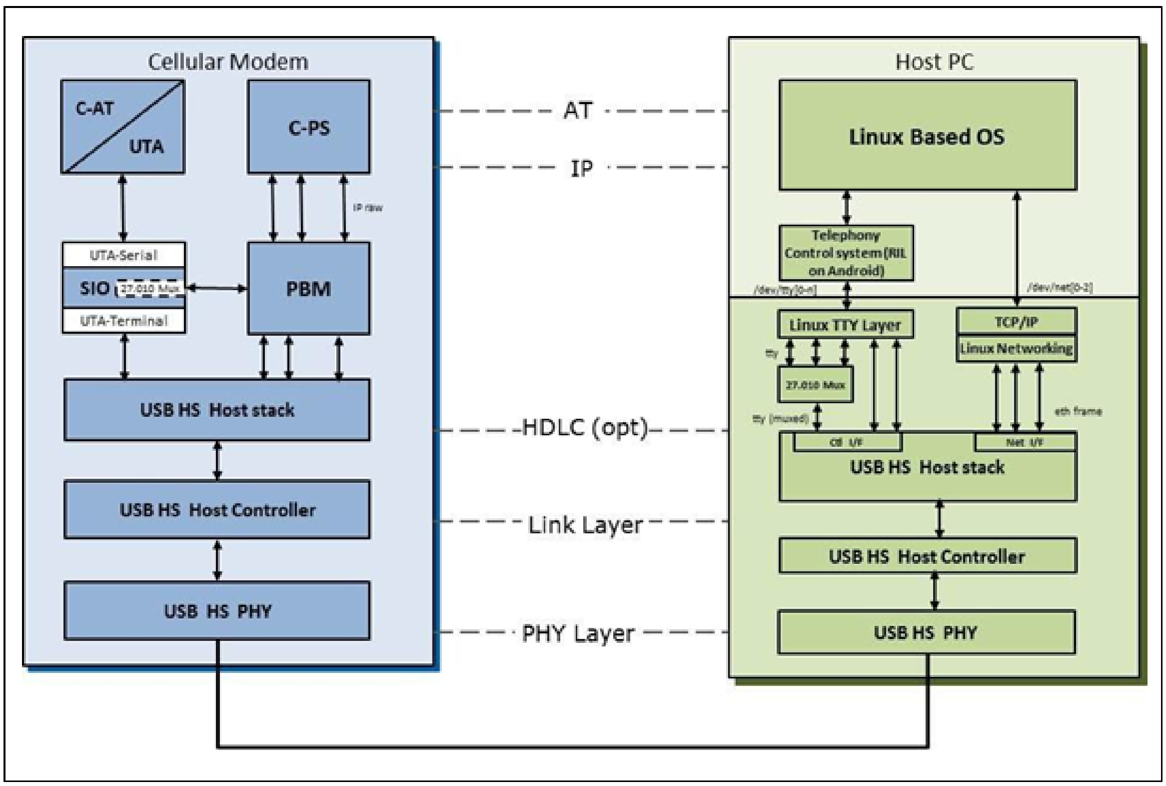

Figure 14 Linux Software Architecture

The user data is transferred from/to the cellular protocol stack (C-PS) to the IPC via a centralized memory manager. The centralized memory manager is called packet buffer manager (PBM). The user data is routed along the data plane as IP packets using several logical channels. Each logical channel corresponds to a dedicated Packet Data Network (PDN) connection.

There is no TCP/IP stack on the modem side in the data path from IPC over PBM to C-PS handling IP address based routing.

The central packet buffer manager (PBM) provides a common packet buffer used between IPC and PS. No copy operation of data is necessary between cellular PS and IPC. The HS-USB interface provides a highly efficient data path via DMA with scatter/gather linked-list processing.

The control plane is using at least one dedicated channel through Serial IO component (S-IO) to the AT command handler. The interface towards the driver is called Universal Terminal Adapter (UTA)-Terminal, while the interface towards application is called UTA-Serial interface. The application in our case is the AT command handler called C-AT. The control channel is using AT commands. A detailed list of all supported AT commands can be found in a separate application note.

6.2 CMUX Multiplexer

In the context of an AT command based architecture, a SW multiplexer can be added. The SW multiplexer of the 3GPP 27.010 protocol provides a number of logical channels (DLC) which serve as AT terminals on Host PC side. These logical channels are mapped on-top of one of the control channels of the specific physical IPC interface.

The 3GPP 27.010 multiplexer protocol is a data link protocol (layer-2 of the OSI model) which uses HDLC-like framing, virtual data channels, and channels' control procedure. The protocol is implemented according to 3GPP TS27.010. It allows software applications on the Host processor to access the USB-HS port on M.2 in a concurrent way by emulating multiple virtual communication channels. The MUX protocol controls the virtual channels and conveys user data over the virtual channels.

6.3 USB 2.0 HS Features

The USB 2.0 HS stack is used for communication with a PC in device role.
Additional details on the USB interface can be found in Section 3.1, Interprocessor Interface.

6.4 USB Configuration

The USB feature may be configured by the UTA_USB API. The user may define different use cases, such as support of different numbers of CDC-ACM or CDC-NCM channels.

6.4.1 Modem Connection

Up to 3 CDC-ACM logical channels are available to be used as an interface for the following functionality:

- AT commands
- 3GPP 27.010 Multiplexer
- Tracing
- Connection to test framework

The ACM channels are connected via UTA-Terminal to S-IO and from there via UTA-Serial to the application on modem side.

6.4.2 Network Connection

Up to 4 CDC-NCM functions are available to be used as interface for network connections servicing for up to four PDN connections.

The NCM channels are connected via the PBM driver interface to PBM and from there via PBM service interfaces to the PTM component of C-PS.

6.4.3 Default Configuration

The default configuration is 3 CDC-ACM channels for control and trace and 4 CDC–NCM channels for data connections. A specific configuration is set via the AT+XSIO command. The detailed usage of the default configuration is:

- 1st ACM channel:: Modem Control Channel, Channel ID: USBCDC/0
- 2nd ACM channel:: Trace data, Channel ID: USBCDC/1
- 3rd ACM channel:: free, Channel ID: USBCDC/2

- 1st - 4th NCM channel: data channel for PDN connection: Channel ID: USBHS/NCM/0-3

6.5 LPM

The host computer can set the modem into USB sleep (L1) state (to save battery power) whenever the link is idle. To return from sleep state the host computer performs L1Resume. This can also be triggered by the modem using L1-Remote- Wake-up. The sleep (L1) state is introduced by "USB 2.0 Link Power Management Addendum" and allows fast state transitions between active and sleep states.

6.5.1 Suspend/Resume and Remote Wake-up

The PC can set the modem into USB suspend state (to save battery power) when no communication takes place or when the PC is switched into standby mode. The suspend state also can be triggered by X-GOLD™ Baseband device through a proprietary device initiated selective suspend mechanism. The wake up is performed by Host Resume. The modem can wake up the host computer from standby state using Remote Wake-up

6.5.2 Android Software Components

The software components of a WWAN M.2 module running the Android operating system is shown Figure 15.

- Android version 15/16 will be supported.
- Intel Intrinsic Radio Interface Layer (RIL) will be used and supported via a USB CDC-ACM driver.
- All Intel features will be supported via AT commands.
- Advanced Linux Sound Architecture (ALSA) will not be supported on data only WWAN M.2 modules.

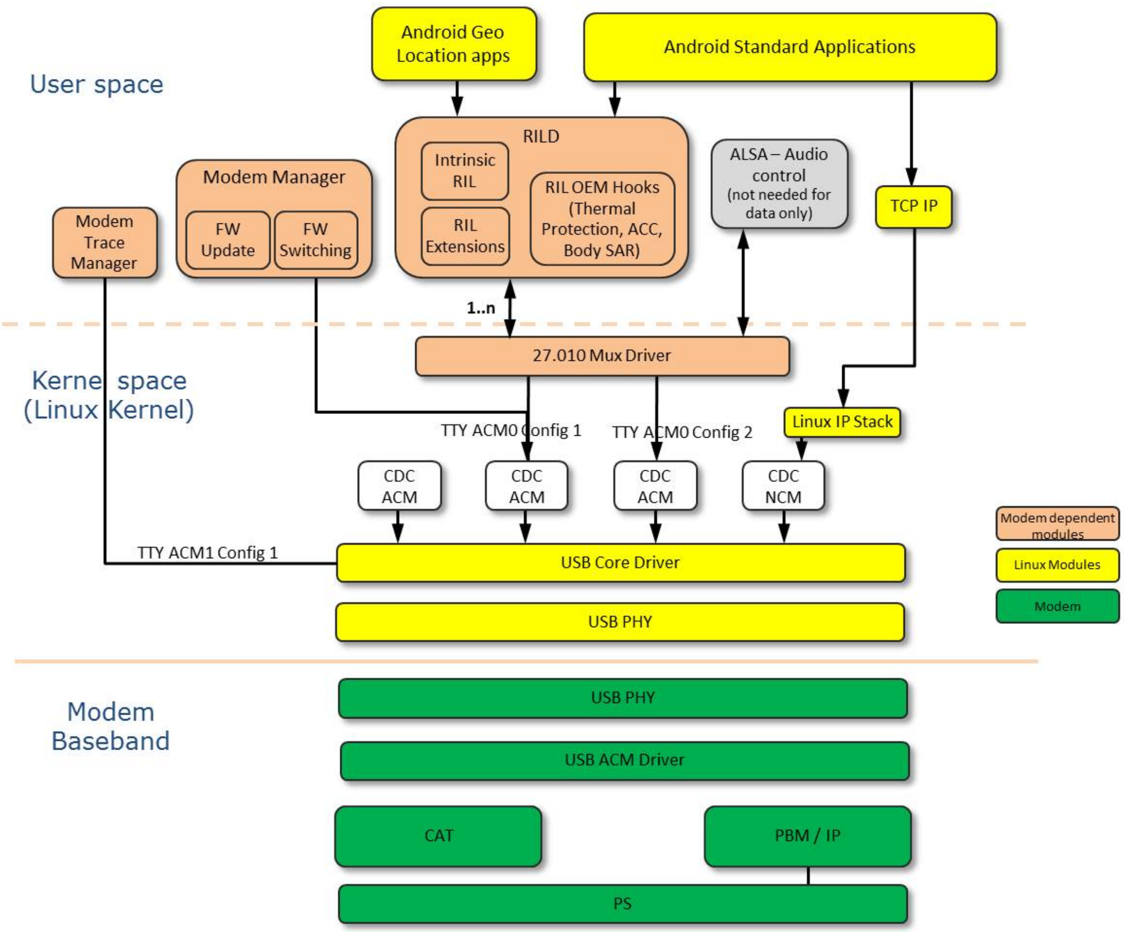

Figure 15 Android Software Architecture

6.5.3 Chrome Software Components

A preliminary view of the software components of a WWAN M.2 module running the Chrome operating system is shown in Figure 16. The architecture is still in development; however, it is expected that:

- Intel Intrinsic Radio Interface Layer (RIL) will be used and supported via a USB CDC-MBIM driver.
- All Intel features will be supported via MBIM commands.
- Advanced Linux Sound Architecture (ALSA) will not be supported on data only WWAN M.2 modules.

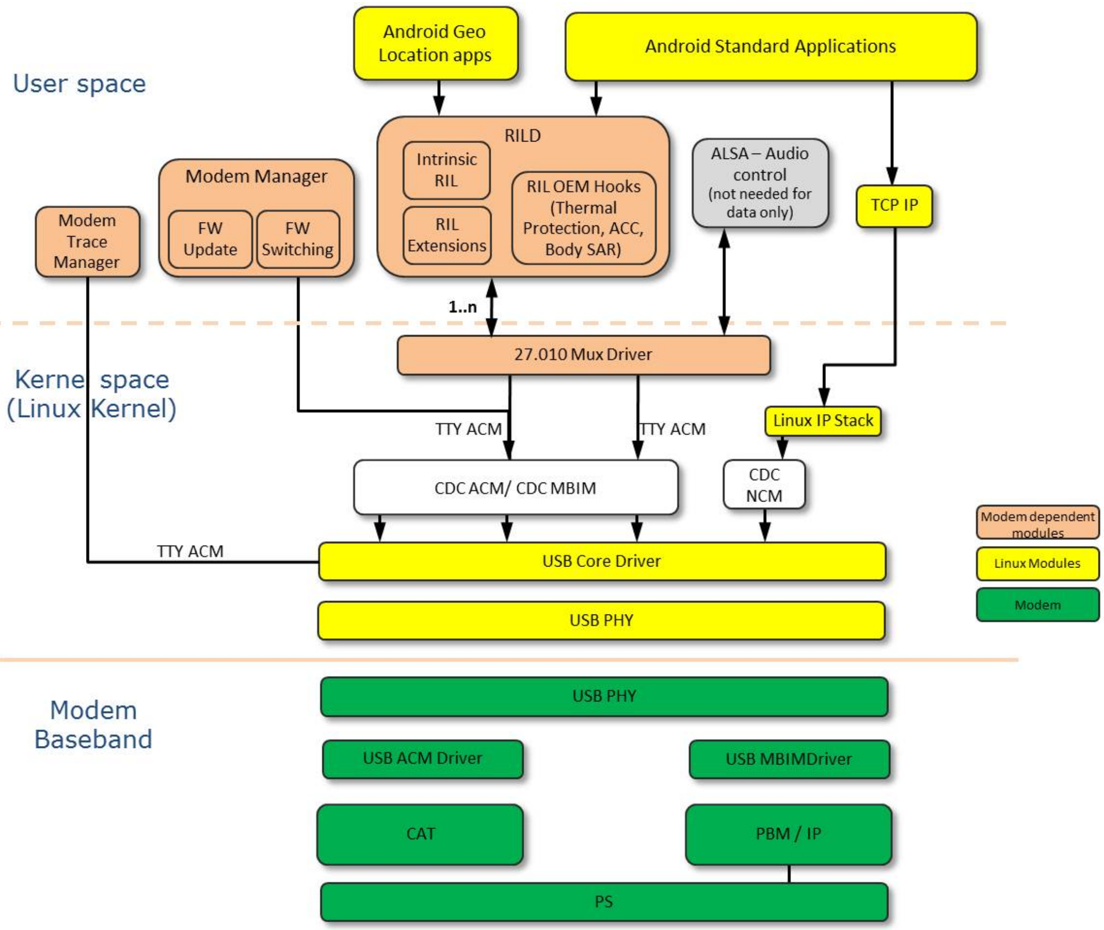

Figure 16 Chrome Software Architecture

7 Operating Environment

Table 24 Operating Environment

Item	Description
Form Factor	Card Type 3042
Operating Temperature	The module full operating temperature in compliance with 3GPP specification shall be -10 °C to +55 °C – Normal +55 °C to +70 °C – Extreme Extreme is the surrounding air temperature of the module inside the platform when the card is fully operating at worst case condition. We cannot guarantee the RF performance of the device, since components might operate out of specification. On the RF side we are using a mechanism called Progressive Power Reduction to limit the PA output power at high operating temperature.
Storage Temperature	-40 °C (minus 40) to +70 °C (plus 70) non-operating.
Humidity	<85% humidity, non-condensing

8 Power Delivery Requirements

8.1 Electrical Parameters (3.3 V Power Supply)

The M.2 modules utilize a single regulated power rail of 3.3 V provided by the host platform. There is no other VDDIO like pin and the M.2 module is responsible for generating its own I/O voltage source using the 3.3 V power rail. This 3.3 V voltage rail source on the platform should always be on and available during the system's stand-by/suspend state to support the wake event processing on the communications card.

There are 5 power pins on the host interface, pins 2, 4, 70, 72, and 74.

The requirements of the regulated 3.3 V power supply provided by the host platform are listed below.

Table 25 M.2 Module Power Delivery Requirements - Ultrabook

Requirement	Detailed Description
Supply voltage	3.3 V at the Card connector will be within 5% tolerance on the motherboard.
Peak Current	The host board shall provide 2.5 A peak current.
Average Current	Average max current of 1.1 A will be supported.
Max in-rush current	Max module in-rush current of 5.1 A will be supported.
Power pin connections	The power pins specified in WWAN card #'s, 2, 4, 70, 72, 74 will be connected to 3.3 V supply and WWAN configuration pins 1, 69, and 75 will be connected to ground.

For Tablet platforms, the 3.3 V regulated power rail can be replaced with a direct VBAT connection. Key parameters for VBAT in a direct connection configuration are shown in Table 26.

Table 26 VBAT Power Delivery Requirements – Direct Connections (Tablet)

Power Source	Vmin	Vmax	Cell Type
VBAT	3.135 V*	4.4 V	Once cell Li-Ion battery

(*) RF performance cannot be guaranteed below 3.135 V.

8.2 Electrical Parameters - Host Interface Signals

Table 27 DC Specification for 3.3V Logic Signaling

Symbol	Parameter	Condition	Min	Max	Unit
+3.3V	Supply Voltage	-	3.135	3.465	V
V_{IH}	Input High Voltage	-	2.0	3.6	V
V_{IL}	Input Low Voltage	-	-0.5	0.8	V
I_{OL}	Output Low Current for Open-drain Signals Not applicable to LED# and DAS/DSS# pins	0.4 V	4	-	mA
I_{OL}	Output Low Current for Open-drain Signals Applies to the LED# pins	0.4 V	9	-	mA
I_{IN}	Input Leakage Current	0 V to 3.3 V	-10	+10	µA
I_{LKG}	Output Leakage Current	0 V to 3.3 V	-50	+50	µA
C_{IN}	Input Pin Capacitance	-	-	7	pF
C_{OUT}	Output Pin Capacitance	-	-	30	pF
$R_{PULL-UP}$	Pull-up Resistance	-	9	60	kΩ

Table 28 DC Specification for 1.8V Logic Signaling

Symbol	Parameter	Condition	Min	Max	Unit
V_{DD18}	Supply Voltage	-	1.7	1.9	V
V_{IH}	Input High Voltage	-	0.7 * V_{DD18}	V_{DD18} + 0.3	V
V_{IL}	Input Low Voltage	-	-0.3	0.3 V_{DD18}	V
V_{OH}	Output High Voltage	I_{OH} = -1 mA V_{DD18} Min	V_{DD18} - 0.45	-	V
V_{OL}	Output Low Voltage	I_{OL} = 1 mA V_{DD18} Min	-	0.45	V
I_{IN}	Input Leakage Current	0 V to V_{DD18}	-10	+10	µA
I_{LKG}	Output Leakage Current	0 V to V_{DD18}	-50	+50	µA
C_{IN}	Input Pin Capacitance	-	-	10	pF

8.3 Power Consumption

This section lists the power consumption targets.

Typical target values at Vsys = 3.3 V

Table 29 LTE Power Consumption

M.2 Power Consumption (*)		Transmit Power	
LTE Use Case	**Band**	**10 dBm**	**23 dBm**
LTE UTP, Cat. 3, 20 MHz, 100 RB - (APAC SKU only)	1	1195 mW	2195 mW
LTE UTP, Cat. 3, 20 MHz, 100 RB - (APAC SKU only)	3	1175 mW	2356 mW
LTE UTP, Cat. 3, 10 MHz, 50 RB - (APAC SKU only)	8	1000 mW	2201 mW
LTE UTP, Cat. 3, 20 MHz, 100 RB - (APAC SKU only)	9	1175 mW	2244 mW
LTE UTP, Cat. 3, 10 MHz, 50 RB - (APAC SKU only)	11	1073 mW	2155 mW
LTE UTP, Cat. 3, 15 MHz, 75 RB - (APAC SKU only)	18	1122 mW	1911 mW
LTE UTP, Cat. 3, 15 MHz, 75 RB - (APAC SKU only)	19	1112 mw	1874 mW
LTE UTP, Cat. 3, 15 MHz, 75 RB - (APAC SKU only)	21	1208 mW	2270 mW
LTE UTP, Cat. 3, 100 Mbps/50 Mbps, 20 MHz – (APAC not included)	7	1068 mW	2531 mW
LTE UTP, Cat. 3, max throughput, 10 MHz – (APAC not included)	17	916 mW	2394 mW
LTE Use Case	**Standby Power**		
LTE Stand-by current, DRX 1.28 s serv. Cell only	8 mW		

(*) Applicable to modules:

- LN930
- LN930-AP

Table 30 UMTS Power Consumption

M.2 Power Consumption		Transmit Power
UMTS Use Case (DC-HSDAP+ or HSDPA+)	**Band**	**10 dBm**
UMTS FTP, Cat. 24, RxDiv (M.2 DC-HSDPA+)	Band 1	988 mW

UMTS FTP, Cat 14, QAM64 (M.2 DC-HSDPA+)	Band 1	771 mW
UMTS FTP, Cat 14, QAM64 (M.2 HSDPA+)	Band 1	813 mW
Standby Power		
UMTS Stand-by current, DRX7, 16NB cells	-	6 mW
UMTS Stand-by current, DRX7, 16NB cells (HN930)	-	6.6 mW

Table 31 GSM Power Consumption

GSM Use Case	Band	Transmit Power
2UL, 1DL, PCL10 (*)	GPRS 900	475 mW
2UL, 1DL, PCL5 (*)	GPRS900	1482 mW
Standby Power		
GSM Stand-by, DRX5, 16NB cells	-	6 mW
GSM Stand-by, DRX5, 16NB cells (£)	-	6.88 mW

(*) Applicable to modules: LN930, LN930-AP, HN930

(£) Applicable to module: HN930 (XMM™ 6260 based)

9 Other Information

9.1 EMI/EMC and Platform Noise

The M.2 Data Card has shielding and noise filtering in place to ensure that the WWAN module does not impact the operation of the host system.

The M.2 Data Card must also be able to tolerate platform noise caused by high order clock harmonics from the host processor and associated support circuitry. It is required that the noise levels (as measured at the antenna connector) in the operating frequencies of the M.2 Data Card be no greater than 5 dB as compared to the noise floor of the host system.

9.2 Platform Noise Mitigation - Adaptive Clocking

Wireless subsystems in mobile platforms are affected by platform related noise, even with the best antenna and chassis design. This noise hampers the wireless radio performance, sometimes severely. For platforms that incorporate wireless subsystems like WWAN, passing the wireless operator certification is an important component of platform launch.

One of the key elements of platform noise, commonly referred to as RF interference, is LCD display panel pixel clock and its harmonics. The pixel clock generates RF that translates directly into noise picked up by platform wireless radios due to the close proximity of display electronics and the integrated antennas in the system. Many of the panel vendors allow the pixel clock to be “tweaked” (i.e. adapt the pixel clock) to shift the harmonics from interfering with the wireless components in operating radio frequencies.

A radio’s receive performance could be improved by moving any harmonics of the graphics pixel clock outside of the frequencies used by the wireless modules. This will be accomplished by shifting the display pixel clock. Shifting the pixel clock is not expected to affect the graphics quality or its performance. The display panel refresh rate will not be changed.

To support crosstalk mitigation, the WWAN module provides an event indication to the host when the channel frequency changes. On the event indication, the host would use the frequency change information (i.e. Center Frequency, Bandwidth, and any other optional information) through an API that would facilitate the facilitating the implementation of a noise mitigation service.

9.3 Thermal Monitoring

The M.2 Data Card includes a digital thermal sensor in order to monitor the temperature of the WWAN Card. The firmware will support the extraction of temperature information from the module and the configuration of auxiliary trip points.

The configuration of the thermal trip points and receipt of thermal data is available through a WWAN power control API in order for the host to implement a power and thermal management framework for the system.

9.4 Seamless Roaming / Wifi Offload

The WWAN M.2 module provides support for EAP methods; EAP-SIM, EAP-AKA, and EAP-AKA'. These methods, which are used on WiFi authentication, require access to WWAN SIM credentials to connect to WiFi Networks and offload from WWAN.

All necessary AT commends needed for the EAP-SIM functionality are supported. In addition, all necessary commands need for the PIN entry, change, and lock/unlock are supported.

Through the API, the host can manage Wi-Fi Hotspot connectivity with Operator provisioned Hotspot SSIDs and/or End-User provided SSIDs and seamlessly offload a data session from a 3G/4G connection to Wi-Fi hotspot connection after successful authentication of the device and authorization of the end-user subscription using the SIM on the platform.

9.5 Conducted Transmit Power

Transmit power as measure at the WWAN antenna connector

Table 32 Conducted Transmit Power – 2G

Parameter	Condition	Requirement
Conducted Transmit Power	850 MHz/900 MHz	33 dBm +/- 3 db
	1800 MHz/1900 MHz	30 dBm +/- 3 db

2G not supported for APAC SKU

Table 33 Conducted Transmit Power – 3G

HDPA+ / LTE LN930		
Parameter	**Condition**	**Requirement**
Conducted Transmit Power[1]	W-CDMA class 3	24 dBm + 1 db /- 3 db
LN930-AP (APAC SKU only)		
Parameter	**Condition**	**Requirement**
Conducted Transmit Power[1]	W-CDMA class 3	24 dBm + 1 db /- 3 db

[1] Conducted transmit power as measured at the WWAN M.2 RF main antenna connector.

Table 34 Conducted Transmit Power – LTE

HDPA+ / LTE LN930		
Parameter	**Condition**	**Requirement**
Conducted Transmit Power[1]	E-UTRA class 3	23 dBm + 0.5/- 1 db
LN930-AP (APAC SKU only)		
Parameter	**Condition**	**Requirement**
Conducted Transmit Power[1]	E_UTRA class 3	22.5 dBm + 0.5 /- 1 db

[2] Conducted transmit power as measured at the WWAN M.2 RF main antenna connector.

9.6 Receiver Sensitivity

The reference sensitivity power level is the minimum mean power applied to both the WWAN M.2 antenna ports at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

Condition: Calibration voltage = 3.3V, 25C shielded room

Table 35 Rx Sensitivity - GSM

Band	Condition	Min Rx Sensitivity Limit (dBm)
GSM850	GMSK	-110
GSM900	GMSK	-109
GSM1800	GMSK	-109
GSM1900	GMSK	-106

Table 36 Rx Sensitivity - UMTS

HDPA+ / LTE LN930		
Band	**Condition**	**Min Rx Sensitivity Limit (dBm)**
1	BER<0.1%	-107
2	BER<0.1%	-106
4	BER<0.1%	-107
5	BER<0.1%	-107
8	BER<0.1%	-107
LN930-AP (APAC SKU only)		
Band	**Condition**	**Min Rx Sensitivity Limit (dBm)**
1	BER<0.1%	-106
6	BER<0.1%	-106
8	BER<0.1%	-103
11	BER<0.1%	-106
19	BER<0.1%	-106

GSM not supported for LN930-AP
Main and Diversity ports are measured separately. Combining both antenna ports increases sensitivity by 3 dB. Table 36 Rx Sensitivity – UMTS reflects both ports combined.

Table 37 Rx Sensitivity - LTE

HDPA+ / LTE LN930							
					EARFCN		
LTE Band	**Duplex**	**Modulation**	**Bandwidth (Hz)**	**Min Rx Sensitivity Limit (dBm)**	**Low Channel**	**Middle Channel**	**High Channel**
1	FDD	QPSK	10	-96	50	320	550
2	FDD	QPSK	10	-95	650	920	1150
3	FDD	QPSK	10	-97	1250	1678	1900
4	FDD	QPSK	10	-96	2000	2110	2350
5	FDD	QPSK	10	-97	2450	2510	2600
7	FDD	QPSK	10	-96	2800	3100	3400
8	FDD	QPSK	10	-97	3525	3625	3750
13	FDD	QPSK	10	-97	5180	5230	5279
17	FDD	QPSK	10	-97	5780	5800	5890
18	FDD	QPSK	10	-97	5900	5925	5950
19	FDD	QPSK	10	-97	6050	6075	6100
20	FDD	QPSK	10	-94	6200	6300	6400

LN930-AP (APAC SKU only)							
					EARFCN		
LTE Band	**Duplex**	**Modulation**	**Bandwidth (Hz)**	**Min Rx Sensitivity Limit (dBm)**	**Low Channel**	**Middle Channel**	**High Channel**
1	FDD	QPSK	10	-96	50	320	550
3	FDD	QPSK	10	-96	1250	1678	1900
8	FDD	QPSK	10	-96	3525	3625	3750
9	FDD	QPSK	10	-96	3850	3975	4099
11	FDD	QPSK	10	-96	4800	4850	4899
18	FDD	QPSK	10	-97	5900	5925	5950
19	FDD	QPSK	10	-97	6050	6075	6100
21	FDD	QPSK	10	-96	6500	6525	6549
26	FDD	QPSK	10	-97	8740	8865	8989

- GSM not supported for APAC SKU
- Main and Diversity ports are measured separately. Combining both antenna ports increases sensitivity by 3 dB. Table 36. Rx Sensitivity – UMTS reflects both ports combined.
- Table 37 is a generic view that includes all LTE bands for Rx sensitivity. The APAC SKU does not include LTE Bands 2, 4, 5, 7, 13, and 17.

9.7 Antenna Recommendations

The following tables provide antenna guidance for the platform designer.

Table 38 Antenna Recommendation

Parameter	Recommendation
Impedance	50 ohm
Antenna Shape and Radiation Pattern	Near Omni-directional in the Horizontal plane is preferred
Polarization	Predominantly vertical polarization and near Omni-Azimuth pattern are desired; H-polarization must not be eliminated (indoor, diversity)
Input Power	33 dBm typical peak power GSM LB* 30 dBm typical peak power GSM HB* 24 dBm typical average power WCDMA 23 dBm typical average power LTE

*Not included for APAC SKU.

Table 39 Antenna Recommendation - Bandwidth of Main & Diversity Antenna

RF Band	Center Frequency	Uplink (UL) UE Tx	Downlink (DL) UE Rx	Duplex Mode	Common Name	Bandwidth of Main Antenna (MHz)	Bandwidth of Diversity Antenna (MHz)
001 I (1)	2100 MHz	1920 MHz to 1980 MHz	2110 MHz to 2170 MHz	FDD	IMT	250	60
002 II (2)	1900 MHz	1850 MHz to 1910 MHz	1930 MHz to 1990 MHz	FDD	PCS	140	60
003 III (3)	1800 MHz	1710 MHz to 1785 MHz	1805 MHz to 1880 MHz	FDD	DCS	170	75
004 IV (4)	1700 MHz	1710 MHz to 1755 MHz	2110 MHz to 2155 MHz	FDD	AWS	445	45
005 V (5)	850 MHz	824 MHz to 849 MHz	869 MHz to 894 MHz	FDD	CLR	70	25
006 VI (6)	850 MHz	830 MHz to 840 MHz	875 MHz to 885 MHz	FDD	UMTS 800	55	10
007 VII (7)	2600 MHz	2500 MHz to 2570 MHz	2620 MHz to 2690 MHz	FDD	IMT-E	190	70
008 VIII (8)	900 MHz	880 MHz to 915 MHz	925 MHz to 960 MHz	FDD	GSM	80	35
009 IX (9)	1800 MHz	1749.9 MHz to 1784.9 MHz	1844.9 MHz to 1879.9 MHz	FDD	UMTS 1800	130	35
010 X (10)	1700 MHz	1710 MHz to 1770 MHz	2110 MHz to 2170 MHz	FDD	Extended AWS	460	60
011 XI (11)	1500 MHz	1427.9 MHz to 1447.9 MHz	1475.9 MHz to 1495.9 MHz	FDD	PDC	68	20
013 XIII (13)	750 MHz	777 MHz to 787 MHz	746 MHz to 756 MHz	FDD	upper SMH block C	41	10
017 XVII (17)	700 MHz	704 MHz to 716 MHz	734 MHz to 746 MHz	FDD	lower SMH blocks B/C (subset of	42	12

RF Band	Center Frequency	Uplink (UL) UE Tx	Downlink (DL) UE Rx	Duplex Mode	Common Name	Bandwidth of Main Antenna (MHz)	Bandwidth of Diversity Antenna (MHz)
					band 12)		
018 XVIII (18)	850 MHz	815 MHz to 830 MHz	860 MHz to 875 MHz	FDD	Japan lower 800	60	15
019 XIX (19)	850 MHz	830 MHz to 845 MHz	875 MHz to 890 MHz	FDD	Japan upper 800	60	15
020 XX (20)	800 MHz	832 MHz to 862 MHz	791 MHz to 821 MHz	FDD	EU's Digital Dividend	71	30
021 XXI (21)	1500 MHz	1447.9 MHz to 1462.9 MHz	1495.9 MHz to 1510.9 MHz	FDD	PDC	63	15.4
025 XXV (25)	1900 MHz	1850 MHz to 1915 MHz	1930 MHz to 1995 MHz	FDD	Extended PCS (superset of band 2)	145	65
026 XXVI (26)	850MHz	814 MHz to 849 MHz	859 MHz to 894 MHz	FDD	ESM+CLR	80	35
027 XXVII (27)	850MHz	806 MHz to 824 MHz	851 MHz to 869 MHz	FDD	ESMR	63	18
028 XXVIII (28)	750MHz	703 MHz to 728 MHz	758 MHz to 803 MHz	FDD	APAC 700	100	45
GPS	1575.42 MHz				GPS L1		35
GLONASS	1602 MHz				GLONASS L1		35

- APAC SKU does not include RF Bands 7, 10, 13, 17, 20, 25, 26, 27, 28

9.8 GNSS Sensitivity

Table 40 GNSS Sensitivity

Parameter	Min Limit (dBm)
Cold Start Sensitivity	-145
Hot Start Sensitivity	-155

10 3GPP Compliance

M.2 module complies with the following listed test standards:

- 3GPP TS 31.121 USIM
- 3GPP TS 31.124USAT
- 3GPP TS51.010-1, 2G PS & RF & RRM
- 3GPP TS 51.010-4 2G SIMTK
- 3GPP TS34.121-1 3G RF & RRM
- 3GPP TS34.123-1 3G PS
- 3DPP TS36.124 LTE Radiated Emission
- 3GPP TS36.521-1 LTE RF
- 3GPP TS 36.521-3 LTE RRM
- 3GPP TS36.523-1 LTE PS
- ETSI TS 102 230 UICC
- OMA ETS SUPL v1.0 LBS SUPL
- OMA ETS SUPL v2.0 LBS SUPL

11 WWAN Card Type 3042-S3-B

11.1 Mechanical Dimensions

The mechanical dimensions of WWAN Card Type 3042 are shown in Figure 17 and Figure 17.

The WWAN card is 30 mm x 42 mm. The height is 1.5 mm from the top of the PCB to the top of the outside shield. There are a total of 75 pins; however 8 pins are lost to support the slot+. All components are mounted on the Top side.

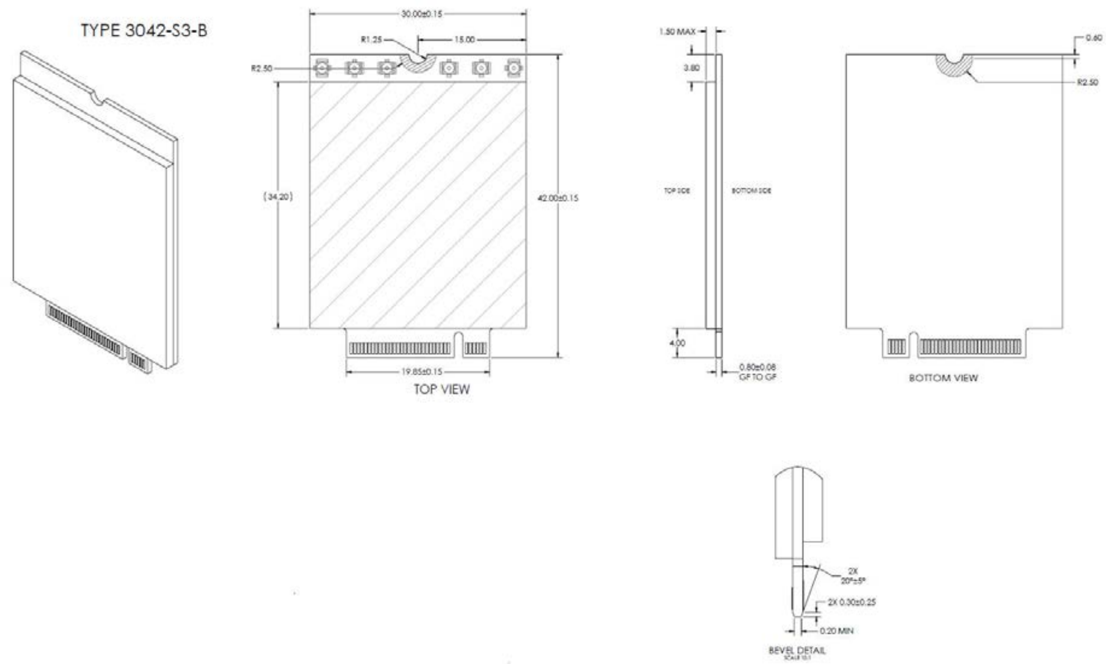

Figure 17 WWAN Card 3042 Mechanical Dimensions

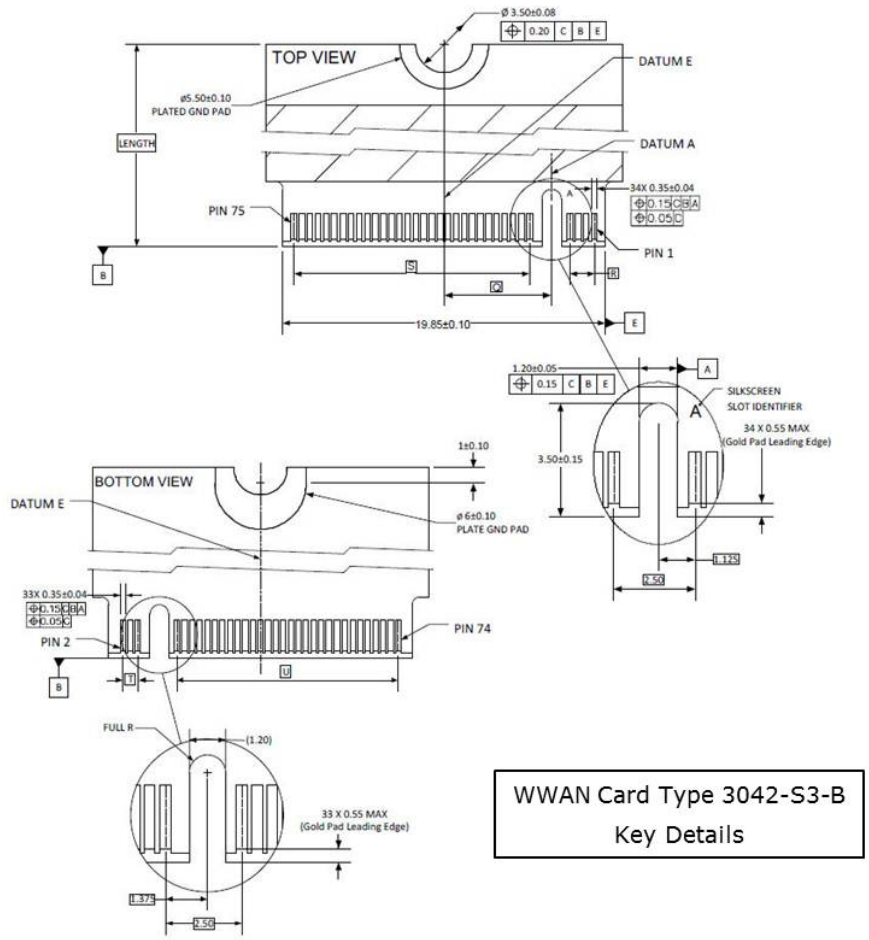

Figure 18 WWAN Card 3042 Slot Key Details

11.2 Land Pattern

Figure 19 illustrates a typical land pattern for a top-mount connector with the key removed.

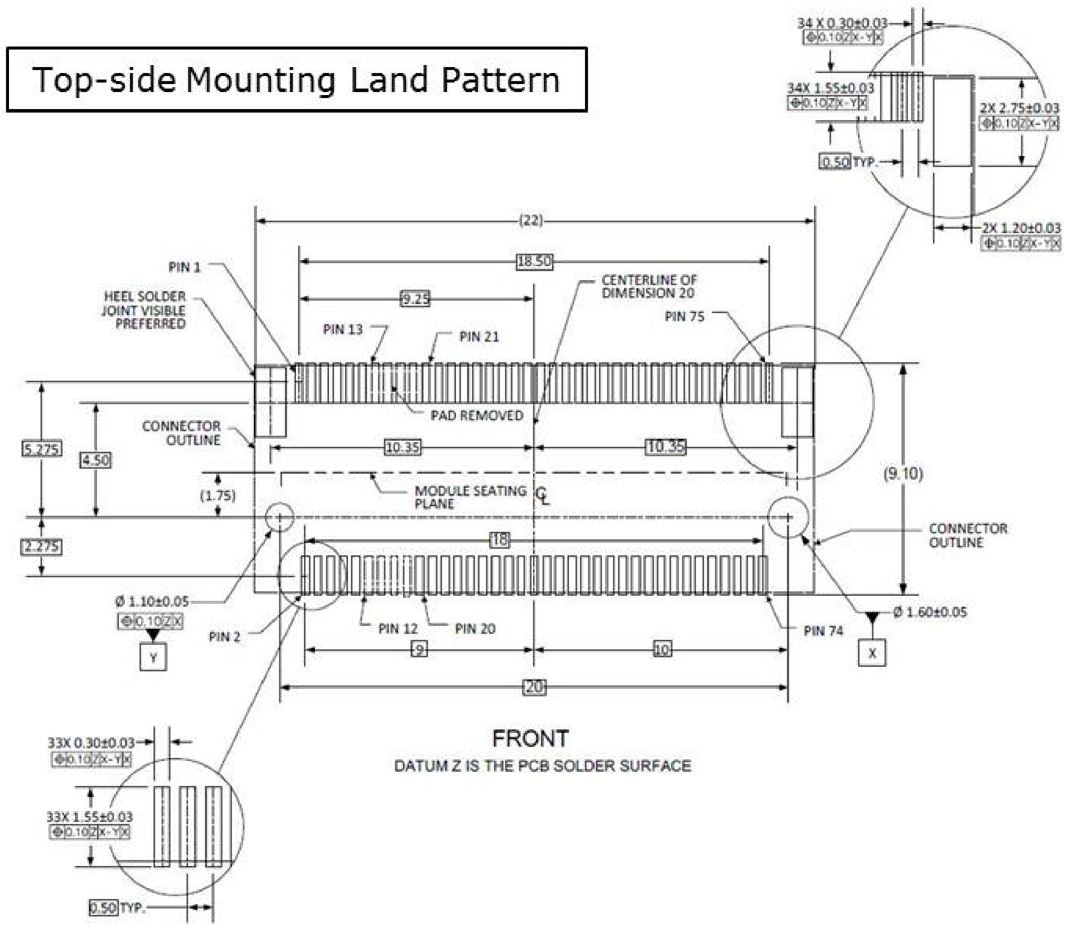

Figure 19 WWAN Card Type 3042 Top-Side Mounting Land Pattern

Figure 20 illustrates a typical mid-plane (in-line) land pattern with slot key removed.

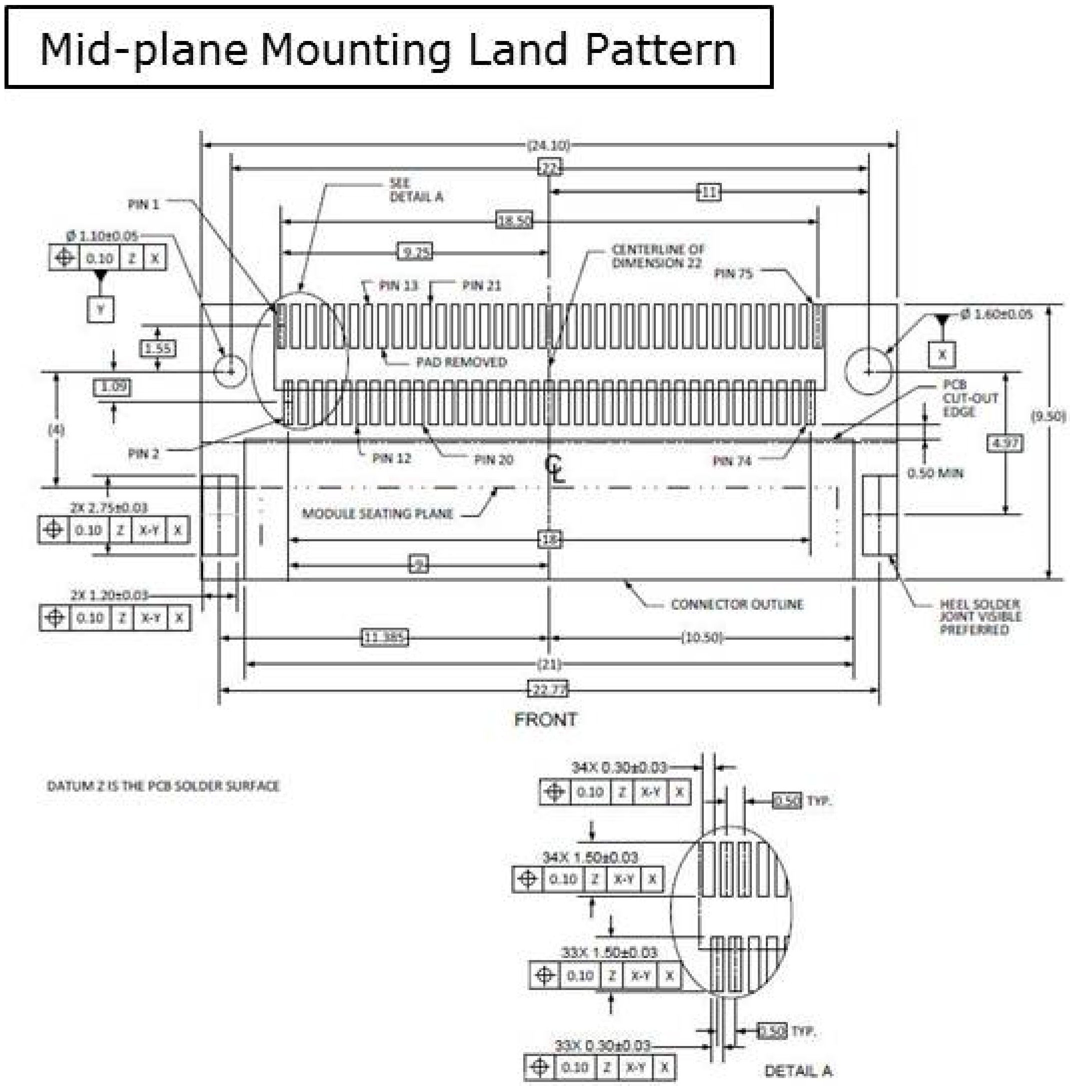

Figure 20 WWAN Card 3042 Mid-plane Land Pattern with Slot Key Removed

11.3 Antenna Connector Locations

Figure 21 illustrates the locations for the main Rx/Tx antenna and the Diversity/GPS antenna.

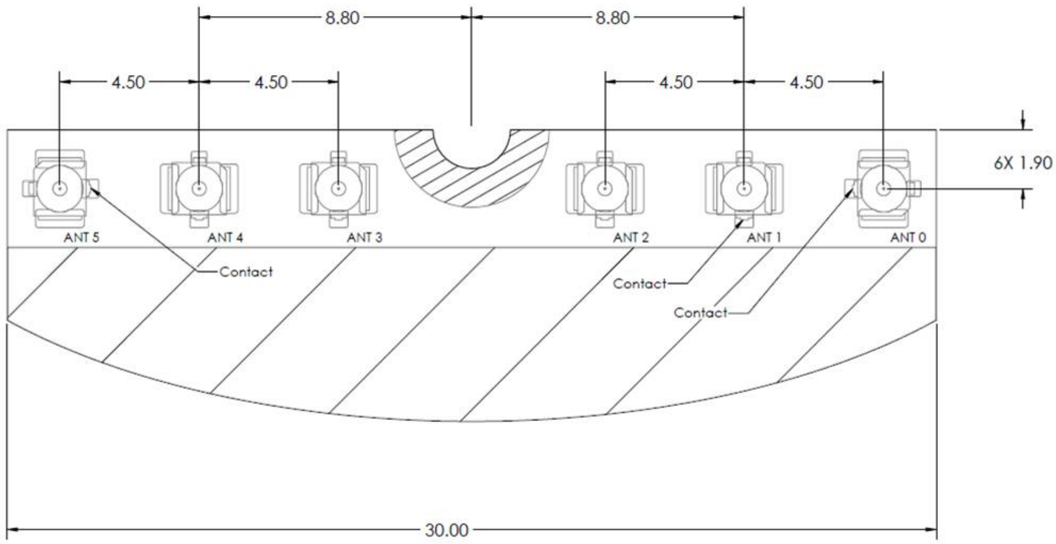

Figure 21 Antenna Connector Location

Table 41 Antenna Connector Assignment

Antenna	Interface
0	TBD
1	Diversity/ GPS
2	TBD
3	TBD
4	WWAN Main Tx/Rx
5	TBD

For M.2 Modules positions 1 and 4 are used. The other antenna connectors are not mounted on the module.

12 Safety Recommendations

READ CAREFULLY

Be sure the use of this product is allowed in the country and in the environment required. The use of this product may be dangerous and has to be avoided in the following areas:

- Where it can interfere with other electronic devices in environments such as hospitals, airports, aircrafts, etc.
- Where there is risk of explosion such as gasoline stations, oil refineries, etc. It is responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity. We recommend following the instructions of the hardware user guides for a correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conforming to the security and fire prevention regulations. The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible of the functioning of the final product; therefore, care has to be taken to the external components of the module, as well as of any project or installation issue, because the risk of disturbing the GSM network or external devices or having impact on the security. Should there be any doubt, please refer to the technical documentation and the regulations in force. Every module has to be equipped with a proper antenna with specific characteristics. The antenna has
to be installed with care in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case of this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The European Community provides some Directives for the electronic equipments introduced on the market. All the relevant information's are available on the European Community website:

http://ec.europa.eu/enterprise/sectors/rtte/documents/

The text of the Directive 99/05 regarding telecommunication equipments is available, while the applicable Directives (Low Voltage and EMC) are available at:

http://ec.europa.eu/enterprise/sectors/electrical/

13 Conformity assessment issues

The following chapters are related to the M.2 module on the EVK carrier board.

13.1 1999/5/EC Directive

The LN930 products portfolio has been evaluated against the essential requirements of the 1999/5/EC Directive.

Bulgarian	С настоящето Telit Communications S.p.A. декларира, че 2G/3G module отговаря на съществените изисквания и другите приложими изисквания на Директива 1999/5/EC.
Czech	Telit Communications S.p.A. tímto prohlašuje, že tento 2G/3G module je ve shodě se základními požadavky a dalšími příslušnými ustanoveními směrnice 1999/5/ES.
Danish	Undertegnede Telit Communications S.p.A. erklærer herved, at følgende udstyr 2G/3G module overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.
Dutch	Hierbij verklaart Telit Communications S.p.A. dat het toestel 2G/3G module in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG.
English	Hereby, Telit Communications S.p.A., declares that this 2G/3G module is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
Estonian	Käesolevaga kinnitab Telit Communications S.p.A. seadme 2G/3G module vastavust direktiivi 1999/5/EÜ põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele.
German	Hiermit erklärt Telit Communications S.p.A., dass sich das Gerät 2G/3G module in Übereinstimmung mit den grundlegenden Anforderungen und den übrigen einschlägigen Bestimmungen der Richtlinie 1999/5/EG befindet.
Greek	ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ Telit Communications S.p.A. ΔΗΛΩΝΕΙ ΟΤΙ 2G/3G module ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ.
Hungarian	Alulírott, Telit Communications S.p.A. nyilatkozom, hogy a 2G/3G module megfelel a vonatkozó alapvetõ követelményeknek és az 1999/5/EC irányelv egyéb elõírásainak.
Finnish	Telit Communications S.p.A. vakuuttaa täten että 2G/3G module tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.
French	Par la présente Telit Communications S.p.A. déclare que l'appareil 2G/3G module est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 1999/5/CE.
Icelandic	Hér með lýsir Telit Communications S.p.A. yfir því að 2G/3G module er í samræmi við grunnkröfur og aðrar kröfur, sem gerðar eru í tilskipun 1999/5/EC
Italian	Con la presente Telit Communications S.p.A. dichiara che questo 2G/3G module è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.
Latvian	Ar šo Telit Communications S.p.A. deklarē, ka 2G/3G module atbilst Direktīvas 1999/5/EK būtiskajām prasībām un citiem ar to saistītajiem noteikumiem.
Lithuanian	Šiuo Telit Communications S.p.A. deklaruoja, kad šis 2G/3G module atitinka esminius reikalavimus ir kitas 1999/5/EB Direktyvos nuostatas.
Maltese	Hawnhekk, Telit Communications S.p.A., jiddikjara li dan 2G/3G module jikkonforma mal-ħtiġijiet essenzjali u ma provvedimenti oħrajn relevanti li hemm fid-Dirrettiva 1999/5/EC.

Norwegian	Telit Communications S.p.A. erklærer herved at utstyret 2G/3G module er i samsvar med de grunnleggende krav og øvrige relevante krav i direktiv 1999/5/EF.
Polish	Niniejszym Telit Communications S.p.A. oświadcza, że 2G/3G module jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 1999/5/EC
Portuguese	Telit Communications S.p.A. declara que este 2G/3G module está conforme com os requisitos essenciais e outras disposições da Directiva 1999/5/CE.
Slovak	Telit Communications S.p.A. týmto vyhlasuje, že 2G/3G module spĺňa základné požiadavky a všetky príslušné ustanovenia Smernice 1999/5/ES.
Slovenian	Telit Communications S.p.A. izjavlja, da je ta 2G/3G modul v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 1999/5/ES.
Spanish	Por medio de la presente Telit Communications S.p.A. declara que el 2G/3G module cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.
Swedish	Härmed intygar Telit Communications S.p.A. att denna 2G/3G module står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.

In order to satisfy the essential requirements of 1999/5/EC Directive, the LN930 is compliant with the following standards:

RF spectrum use (R&TTE art. 3.2)	EN 300 440-2 V1.4.1 EN 301 511 V9.0.2 EN 301 908-1 V6.2.1 EN 301 908-2 V5.2.1 EN 301 908-13 V5.2.1 EN 300 440-1 V1.6.1
EMC (R&TTE art. 3.1b)	EN 301 489-1 V1.9.2 EN 301 489-3 V1.4.1 EN 301 489-7 V1.3.1 EN 301 489-24 V1.5.1
Health & Safety (R&TTE art. 3.1a)	EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 EN 62311: 2008

The conformity assessment procedure referred to in Article 10 and detailed in Annex IV of Directive 1999/5/EC has been followed with the involvement of the following Notified Body:

Thus, the following marking is included in the product:

CE 0682

The full declaration of conformity can be found on the following address:
http://www.telit.com/

There is no restriction for the commercialization in all the countries of the European Union.

Final product integrating this module must be assessed against essential requirements of the 1999/5/EC (R&TTE) Directive. It should be noted that assessment does not necessarily lead to testing. Telit Communications S.p.A. recommends carrying out the following assessments:

RF spectrum use (R&TTE art. 3.2)	It will depend on the antenna used on the final product.
EMC (R&TTE art. 3.1b)	Testing
Health & Safety (R&TTE art. 3.1a)	Testing

Alternately, assessment of the final product against EMC (Art. 3.1b) and Electrical safety (Art. 3.1a) essential requirements can be done against the essential requirements of the EMC and the LVD Directives:

- Low Voltage Directive 2006/95/EC and product safety
- Directive EMC 2004/108/EC for conformity for EMC

13.2 CE RF Exposure Compliance

This device meets the EU requirements (1999/519/EC) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) on the limitation of exposure of the general public to electromagnetic fields by way of health protection.
To comply with the RF exposure requirements, this module must be installed in a host platform that is intended to be operated in a minimum of 20 cm separation distance to the user.

13.3 R&TTE Regulation:

In all cases assessment of the final product must be met against the Essential requirements of the R&TTE Directive Articles 3.1(a) and (b), safety and EMC respectively, as well as any relevant Article 3.3 requirements.

1. The Dipole antenna (gain: GPRS/EGPRS/WCDMA/LTE: 2dBi) was verified in the conformity testing, and for compliance the antenna shall not be modified. A separate approval is required for all other operating configurations, including different antenna configurations.
2. If any other simultaneous transmission radio is installed in the host platform together with this module, or above restrictions cannot be kept, a separate RF exposure assessment and CE equipment certification is required.

14 FCC/IC Regulatory notices

14.1 Modification statement

Telit has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user’s authority to operate the equipment.

Telit n’approuve aucune modification apportée à l’appareil par l’utilisateur, quelle qu’en soit la nature. Tout changement ou modification peuvent annuler le droit d’utilisation de l’appareil par l’utilisateur.

14.2 Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

CAN ICES-3(B)/ NMB-3(B)

14.3 Interference statement

This device complies with Part 15 of the FCC Rules and 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.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

14.4 FCC Class B digital device notice

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.

14.5 Radiation Exposure Statement

This equipment complies with FCC/IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

14.6 End Product Labeling

When the module is installed in the host device, the FCC/IC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: “Contains FCC ID: RI7LN930”, “Contains IC ID: 5131A-LN930”. The grantee's FCC/IC ID can be used only when all FCC/IC compliance requirements are met.

This device is intended only for OEM integrators under the following conditions:
(1) The antenna must be installed such that 20 cm is maintained between the antenna and users,
(2) The transmitter module may not be co-located with any other transmitter or antenna.
(3) To comply with FCC/IC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile exposure condition must not exceed:

- 5.0 dBi in Cellular band
- 3.0 dBi in PCS band
- 5.5 dBi in AWS band
- 5.0 dBi in 700 MHz band
- 5.0 dBi in 2500MHz band

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization is no longer considered valid and the FCC/IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC/IC authorization.

15 Document History

Revision	Date	Changes
0	2013-05-20	First issue
1	2013-07-09	• Update setting for Pin 21 on the host interface. This signal is not connected. • Updated pin names of pins 1, 21, 69, and 75 in Table 4 and Table 19 to simply reflect HW Configuration use. • Updated Table 24 to indicate configuration pins 1, 69, and 75 are tied to GND. • Rename section 3.6 Coexistence Interface to In-Device Coexistence Interface. Additional information on the Inter-device coexistence support was added. • Updated section 4.1.3 System Trace Tool Section. • Updated Figure 5 – RF Engine for WW SKU. • Add further information USB LPM to USB section • Added information on Seamless Roaming & Wifi Off-load – SIM_EAP, SIM-AKA under Other Requirements • Added information on Antenna Design Guidelines under Other Requirements.
2	2013-07-29	RF bands updated
3	2013-08-26	Updating on RF bands Updated section 3.5 and 3.4.5 Updated temp range
4	2013-09-09	HN930-DC product was removed from portfolio
5	2013-09-15	Main & Diversity antenna positions have been swapped. • Updated documentation accordingly, Figure 6 and Figure 10. • Updated WWAN M.2 Mechanical drawings, Figure 14 through Figure 17. • Updated Card_power_ON_OFF description for UltraBook in Table 9. • Updated comments in Table 15 regarding the DPR#/SAR signal. • Updated SIM DTECTED signal to indicate an external pull-up. • Updated Platform Block Diagrams to show DPR# signal is connected to an EINT pin (not GPIO) on XGOLD. • Identified Audio Signals on host interface in Table 4. Previously these were simply defined as Reserved. • Updated VBAT requirements in Table 24 and Table 25.
6	2013-11-20	• Regulation section was updated • Adding support for UMTS Band 6 to M.2 APAC SKU (see Table 2). • Updated 3G RF Band support for APAC Module, supported bands are 1, 8, 11, and 19. (see Table 2) • Added Measured Values for 2G/3G Rx Sensitivity Table 31 and Table 32. • Update Measured Value and changed header name in Rx Sensitivity LTE Table 33 • Modified supply voltage lower spec for Ultra book in Table 24. • Update Table 4, Table 6, Table 26 voltage levels for USB and SIM pins. • Added LTE conditions and added Table 33.

7	2014-04-10	• Added SSIC to ICP interface. Updated RESET signal definition. Updated Antenna figures.
		• Updated Conducted Transmit Power requirements, Table 32.
		• Section 2.2, Table 4
		  • Changed UIM signals pins 30, 32, 34, 36
		  • Replaced dash with underscore in signal names.
		  • Changed supply voltage for Antenna Tuning Signal (ANTCTL*) from (1.7 V – 2.6 V) to 1.8 V.
		• Section 3.5, Table 20 changed supply voltage for Antenna Tuning Signals (ANTCTL*) from (1.7 V – 2.6 V) to 1.8 V.
		• Section 3.11, Table 25 correction to both no connect pins and key slot pins.
		• Section 8.2, Table 27
		  o Changed the max voltage to 3.0 V for WAKE_WWAN# signal
		  o Changed Typ voltage and max voltage for the Antenna Tuning Signals to 0/1.8 V and 2.3 V respectfully

		• Correction in Section 11.3, fixed typo in sentence: For WWAN M.2 Modules, only positions 1 and 4 are used. • Updated table to only indicate minimum RX sensitivity limit. • Updated Section Conducted Transmit Power section. • Added CAT 4: DL 150 Mbps, UL 50 Mbps to APAC LTE in Table 3 • Deleted LED Blink Status in Table 14 • Updated Table 4 and Table 27 • Added Humidity Requirement • Removed Quality & Reliability section since this is a requirement of the ODM. • Correction to: DPR signal includes pull-up, SSIC N/P pin locations, COEX pin names.

8	2014-06-24	• Added IC Canada certification wording.
		• Section 3.2.1, SIM Design Recommendations - added new section
		• Section 3.12, Antenna Interface changed connector of the WWAN antenna cable to iPEX MHF4 from Hirose W.FLT
		• Section 7, Table 24. Operating Environment changed description for Operating Temperature to include extreme temperature +55 °C to +70 °C and added additional description
		• Section 8.2, deleted Table 27. Electrical Parameters – Host Interface Signals and replaced it with:
		    o Table 27. DC Specification for 3.3 V Logic Signaling
		    o Table 28. DC Specification for 1.8 V Logic Signaling
		• Section 8.3, Table 29. LTE Power Consumption
		    o Added additional LTE Use Cases for APAC SKU only - Bands 1, 3, 8, 9, 11, 18, 19, and 21
		    o Changed standby power to 8 mW
		• Section 9.6, -
		    o Table 35. Rx Sensitivity – GSM - added note indicating that GSM is not supported for APAC SKU.
		    o Table 36. Rx Sensitivity – UMTS– added note indicating that the minimum limits reflects that the main and diversity ports are combined.
		    o Table 37. Rx Sensitivity – LTE – added note indicating that the 8 LTE bands 2, 4, 5, 7, 13, 17, 20, and 26 is not supported for APAC SKU
		• Section 9.7, Antenna Recommendations
		    • Table 38. Antenna Recommendation, added note indicating that the first 2 recommendations for Input Power are not supported for APAC SKU.
		    • Table 39. Antenna Recommendation - Bandwidth of Main & Diversity Antenna - added not indicating that the following 9 RF Bands 007, 010, 013, 017, 020, 025, 026, 027, and 028 are not supported by the APAC SKU.

9	2014-11-18	• Replaced Requirement with Target in Table 32 to Table 37. • Changes to Table 32. Conducted Transmit Power – 2G • Changes to Table 33. Conducted Transmit Power – 3G • Changes to Table 34. Conducted Transmit Power – LTE • Changes to Table 35. Rx Sensitivity – GSM • Changes to Table 36. Rx Sensitivity – UMTS • Changes to Table 37. Rx Sensitivity – LTE • Changes to Table 38. Antenna Recommendation
10	2014-12-21	• Added note to Table 3. WWAN M.2 Module – Data Services • − The change is to describe we can support DL 150 Mbps in WW LTE SKU. This is only for generic SW and VZW SW, but not for AT&T SW. • Changes to Section 3.2 USIM Interface • − Bullet number 2 and 3 • Changes to Section 3.2 USIM Interface List number 2 and 3 • Changes to Table 4. WWAN M.2 Host Interface Signals pins 29, 31, 35, and 37. • Changes to Table 6. USB SSIC - ICP Interface • Changes to Table 33. Conducted Transmit Power – LTE • Changes to Table 4. WWAN M.2 Host Interface Signals pins 29, 31, 35, 37, and 67. • Changes to Table 36. Rx Sensitivity – LTE

		• Added new table, Table 39. GNSS Sensitivity