Intel® Wireless WiFi Link 4965AGN

Hardware Specification

Revision 1.0

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1 Introduction

Intel® Wireless WiFi Link 4965AGN (hereafter referred to as 4965AGN) is the first IEEE 802.11n draft compliant adapter from Intel for Mobile and Desktop systems. 4965AGN is designed to address the corporate and consumer market segments in mobile and desktop form factors. The 4965AGN supports both 2.4GHz and 5GHz bands with 4 PHY Modes: IEEE 802.11n draft 1.02, IEEE 802.11b, IEEE 802.11g, and IEEE 802.11a. The 4965AGN can operate on 20MHz and 40MHz channels. The 4965AGN contains 2 key Intel designed silicon components: a programmable MAC/Baseband (4965AGN-M), and an advanced RFIC (4965AGN-R). 4965AGN will be offered on a standard PCI Express MiniCard form factor and mechanical interface. The host interface is based on the PCI Express MiniCard Specification standard.

The 4965AGN includes 2 transmitter and 3 receiver chains, to allow 2x3 MIMO. 4965AGN shall also work in platforms with only 2 antennas connected (there will not be a special SKU for platforms with 2 antennas). 4965AGN can operate on a 40MHz wide channel, reaching PHY rates of up to 300Mb/s. 4965AGN can be configured via SW to use 2x3 or 2x2.

1.1 Product Overview

The 4965AGN hardware transfers data at speeds of up to 300 Mbps instantaneous data rate over the air, between two or more users or between a user and a wired network. The 4965AGN hardware is compliant with the latest IEEE 802.11 standards (fully compliant to IEEE 802.11n draft 1.02). It is based on the PCI Express MiniCard Electromechanical Rev 1.1* Specification and Advanced Configuration and Power Interface (ACPI)* 3.0 specifications. The 4965AGN hardware will be Microsoft Windows Hardware Quality Lab (WHQL)* certified, Wi-Fi Alliance (WFA)* certified, and Cisco Compatible Extensions* certified.

1.2 Key Features

Key features of the 4965AGN hardware include the following:

- Design based on the PCI Express MiniCard Electromechanical Rev. 1.1 Specification
- MIMO (Multiple Input, Multiple Output) Support 802.11n with 2x3 MIMO and 2x2 MIMO
- Dual-Band/Quad-Mode support (IEEE 802.11a/b/g/n), compatible with IEEE 802.11d /e (Quality of Service [QoS]), 802.11h, and European Telecommunication Standards Institute [ETSI] specifications), and IEEE 802.11i (pre-authentication)
- Intel® AMT for enterprise networks in S0/H0 and S0/Hx modes (requires MCH8/ICH8)
- Uses the 5.170 to 5.825-GHz Industrial, Scientific, and Medical (ISM) frequency band as defined by the IEEE 802.11a specification
- 4965AGN can operate on a 40MHz wide channel in 5 - 6 GHz
- Supports data rates 1, 2, 5.5, and 11 Mbps in CCK mode
- Supports data rates 6, 9, 12, 18, 24, 36, 48, and 54 in OFDM mode
- Supports a subset of the combinations of GI, MCS and BW defined in 802.11n (see sections rates).
- Supports channels 1 through 13 (IEEE 802.11b/g specifications); channel support is regulatory SKU-dependent and subject to change
- Provides 128- and 64-bit WEP encryption, hardware AES (support for key sizes of 128 bits, 192 bits, and 256 bits)
- Hardware capability to support Cisco* Compatible Extensions v1/2/3/4
- Supports IEEE 802.11 Power Save Protocol (PSP)

- Supports Basic Service Set (BSS) (AP) and Independent Basic Service Set (IBSS) (peer-to-peer) modes
- Supports Intel® Wireless Coexistence System (WCS) Phase II + (with IBSS support)
- Supports Radio On/Off control by hardware and/or software
- Supports product SKUs to support regulatory variations in different geographical regions. Support is subject to change.
- Automatic switching between the two bands (2.4 GHz and 5.0 GHz)
- Wake on WLAN (WoWLAN) support

2 System Architecture

The dual-band 2.4-GHz/5.0-GHz 4965AGN hardware is based on the PCI Express MiniCard Rev. 1.1 Specification, using a design featuring the 4965AGN-M and the 4965AGN-R 2.4-GHz/5.0-GHz chipset. The 4965AGN-M acts as the interface between the MiniCard slot (ICH8-M PCI Express signals provided from the system board) to the MAC/physical (PHY) layer. The 4965AGN-R acts as the radio frequency (RF) up-converter for transmission at the desired channel frequency (or center frequency). It also acts as the RF down-converter for reception of the desired channel frequency (or center frequency) and recovery of the original base-band modulated signal.

The 4965AGN-R also includes two integrated Voltage Control Oscillators(VCO): main VCO (for high band 5.2GHz) set frequencies between 3.2GHz – 4GHz, mini VCO (lower band 2.4GHz) set frequency of ~680MHz. In addition, components include integrated RF front-end models (FEM) consisting of Balun-Filter Devices, Dual-Band Power Amplifier (PA), discrete Dual-Band Low-Noise Amplifier (LNA), and Switch Diplexer Module (SDM). In addition, there is a single discrete 40-MHz Crystal (XTAL) and three antenna connectors. The 40MHz clock has a maximum of 20ppm frequency stability. It is multiplied up to generate the transmit signal. Hence when operating in the b/g band at 2.412GHz we will have an error of 2.412GHz*20ppm when tuned to the lower channel and at the extreme it will be 2.484GHz * 20ppm when tuned to the upper channel. When operating in the a band it has an error of the frequency of operation*20 ppm.

Data transmission is always initiated by software, which is then passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets (ACKs, CTS, PSPoll, etc...) are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which it then turns off at the end of the packet. Therefore, the transmitter will be on only while one of the aforementioned packets is being transmitted.

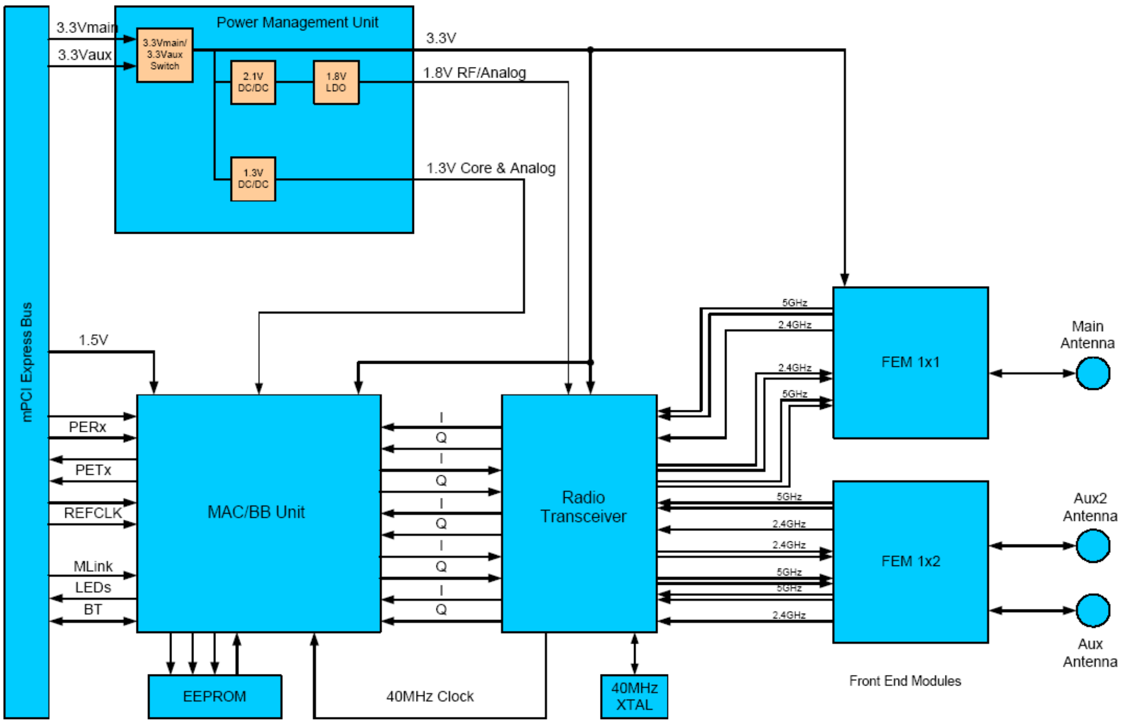


Figure 1: Block Diagram of the 4965AGN Hardware

3 Features

3.1 Wireless Intel® AMT

Intel® AMT enables IT managers to remotely access every networked computing system, even systems that are powered down, the operating system has locked up or the hard drive has crashed. Intel AMT is integrated into tamper-resistant hardware and firmware to prevent intentional or inadvertent removal of inventory, remote control or virus-protection agents from the systems. The technology features an out-of-band link that is independent of the operating system, allowing IT managers to access a system even if the operating system is inoperative.

Note: For more details regarding the above features please refer to Santa-Rosa design guide. See Section 14 References for document information.

4 Electrical Specifications

This section provides information about the electrical specifications for 4965AGN hardware. The specification covers the 4965AGN hardware Interface Signals, Power Consumption, and DC and AC characteristics. Please refer to the PCI Express Card Electromechanical Specification Rev. 1.1 and the PCI Express Base Specification, Rev. 1.1, for more details.

4.1 4965AGN Network Connection Hardware Interface Signals

The 4965AGN hardware design is based on the PCI Express MiniCard Electromechanical Specification. System interface signals are described in Table 1.

Table 1: PCI Express MiniCard System Interface Signals

Signal Group	Signal	Direction	Description
Auxiliary Signals (3.3V Compliant)	PERST#	Input	Functional Reset to the card
	CLKREQ#	Output	Reference clock request signal
	WAKE#	Output	Open Drain active low signal. This signal is used to request that the system return from a sleep/suspended state to service a function initiated wake event.
PCI Express	REFCLK+, REFCLK-	Input	PCI Express differential reference clock (100 MHz)
	PETp0, PETn0 PERp0, PERn0	Input/Output	PCI Express x1 data interface: One differential transmit pair and one differential receive pair
Bluetooth*	BT_CHCLK	Input	The WLAN uses the BT_CHCLK pin to receive the multiplexed Priority signal/Clock signal from the Bluetooth* module. Active high input from Bluetooth* module to card distinguishes Priority from the Channel Clock signal.
	BT_DATA	Output	The WLAN uses the BT_DATA pin to communicate the current WLAN channel in use and its corresponding channel activity status to the Bluetooth* module. This signal is an active high output from the MiniCard to the Bluetooth* module.
Power	+3.3 V (2 pins)	Input	Primary 3.3 V source
	+3.3 V (1 pin)	Input	Auxiliary 3.3 V source
	+1.5 V (3 pins)	Input	Primary 1.5 V source
	GND (13 pins)	N/A	Return current path
LED	LED_WLAN#	Output	WLAN status indicator
C-Link	Clink_RST	Input	
	Clink_DAT	Input/Output	
	C-Link_CLK	Input/Output	
Wireless Disable	W_Disable#	Input	Disables RF portion of the MiniCard

Signal Group	Signal	Direction	Description
Reserved	8,10,12,14,16,17, 19,30,32,36, 38,39,41,45,47, 49,51 (17 pins)	N/A	N/A
NC	40,42 (2 pins)	N/A	N/A

4.2 4965AGN Network Connection Pin-Out Definitions

Table 2: 4965AGN Hardware Pin-Out

Pin #	Name	Buffer/State (Power-Up Reset)	Pin #	Name	Buffer/State (Power-Up Reset)
1	WAKE#	Open Drain/Tri-State	2	3.3V	
3	BT_DATA	Internal Pull – Down ~ 100kΩ	4	GND	
5	BT_CHCLK	Internal Pull – Down ~ 100kΩ	6	1.5V	
7	CLKREQ#	Open Drain/ Internal Pull – Down ~ 100kΩ	8	Reserved	
9	GND		10	Reserved	
11	REFCLK-		12	Reserved	
13	REFCLK+		14	Reserved	
15	GND		16	Reserved	
17	Reserved		18	GND	
19	Reserved		20	W_DISABLE#	Internal Pull – Up ~ 110kΩ
21	GND		22	PERST#	Tri-State
23	PETn0		24	+3.3Vaux	
25	PETp0		26	GND	
27	GND		28	+1.5V	
29	GND		30	Reserved	
31	PERn0		32	Reserved	
33	PERp0		34	GND	
35	GND		36	Reserved	
37	GND		38	Reserved	
39	Reserved		40	NC	
41	Reserved		42	NC	
43	GND		44	LED_WLAN#	Internal Pull – Up ~ 100kΩ

Pin #	Name	Buffer/State (Power-Up Reset)	Pin #	Name	Buffer/State (Power-Up Reset)
45	C-Link_CLK		46	LED_WPAN#	
47	C-Link_DAT		48	+1.5V	
49	C-Link_RST		50	GND	
51	Reserved		52	+3.3V	

4.2.1 No Connect (NC) Signals

All NC pins are "unused" on the 4965AGN hardware pin-out. These pins include signals that are defined as optional by the PCI Express MiniCard Electromechanical Specification as well as reserved pins that are currently not in use.

Note: Pin 40 will be in NC state (should be approved in the coming PCIe MiniCard spec).

4.2.2 Reserved Signals

Unless specified, all reserved pins must remain unconnected. Connection of these pins to power, ground, or to any other signal (including each other) can result in component malfunction or incompatibility with future products.

4.2.3 Power

All power pins are connected to a power bus that should be tied to 1.5V and 3.3V via the connector.

4.2.4 Ground (GND)

All ground pins are connected to a common ground bus that should be tied to system ground via the connector.

Note: Pins 37, 43 will be driven to GND state (should be approved in the coming PCIe MiniCard spec).

4.3 ACPI Device State Support

The 4965AGN hardware is ACPI 3.0 compliant, supporting the peripheral power states D0 and D3. (For more details, please refer to the ACPI Specification, Rev 3.0.) Supported D-states are listed in Table 3.

Table 3: Supported D-States

ACPI 2.0c Specification Device Power States	4965AGN Hardware
D0 (Uninitiated and Active)	Supported
D3 (hot and cold)	Supported

4.4 4965AGN Hardware Power Consumption Pins

Power consumption is measured using the following pins:

- **3.3V Main** – Pin 2, 52 (This is the main Kedron power rail supplying power to the radio, base-band and RF components.)

- **3.3V AUX** – Pin 24 (This is the Kedron power rail supplying power to the basic detection circuitry during the WoWLAN Sleep State [D3 Cold State].)
- **1.5V** – Pin 6, 28, 48 (This is the Kedron power rail supplying power to the PCI Express interface circuitry – Link States between ICH7-M and Kedron)

The 3.3V Main and 3.3V AUX rails are isolated power planes within the MiniCard. Therefore, 3.3V Main is never connected to 3.3V AUX. Both 3.3 V AUX and 3.3 V Main are delivered from the system board to a switch on the MiniCard. The switch can be either in the 3.3V Main state or the 3.3V AUX state.

Generation of PME, reporting status and enabling PME: The MiniCard uses a PME to request a change from a power savings state (S3/S4) to the fully operational state (full power) -> Wake-up Event (WoWLAN).

The MiniCard can be disconnected / or not supplied by system power rails only if the MiniCard input pins that are connected to the system board are also disconnected as well.

4.4.1 4965AGN Power Consumption Targets

Given the configurability of the NIC and the wide range of parameters and modes of operations, power consumption targets are defined for states where the system is expected to spend long periods of time (e.g. for battery life), or where the system is expected to reach maximum throughput (e.g. for benchmarks). Unless otherwise specified, the numbers below represent the sum of 1.5V and 3.3Vmain power consumption by the NIC.

4965AGN power consumption targets are based on 4965AGN-M and 4965AGN-R estimations.

Comments:

- For “battery life” calculations we should use the “Idle associated mode”
- Those values are not including the LED Power consumptions. Measured with non-active-LED.
- Assuming ASMP enabled (L1-active and L0s are enabled).
- All measurements using AP set to TBTT = 100mSec, DTIM=3, Station power set to default (except for Idle with PSP modes, where Station power set to “Max Battery Life”, and in WoWLAN DTIM=5).

The estimates below assume:

3.3V and 1.5V provided by the platform

During Idle and Disabled modes (low power consumption), DC/DC efficiency is only 70%

40MHz wide channel are enabled

Scale & Matrix – use mW (Milli Watts)

Dx and Sx states are defined in the ACPI Spec, and the Lx states are defined in the PCIe spec. The estimations are base on 5.2 band. For the 2.4 band they are significantly lower.

Table 4: 4965AGNPower Consumption Targets

Name	Requirement
Not configured	The laptop is on and NIC is powered. The adaptor is not configured and thus neither transmitting nor receiving. NIC will respond to PCI configuration commands. Power states: D0, S0, L1a Target: 16mW
Disabled	The laptop is on and NIC is powered. The adaptor is configured but disabled (through SW/ OS GUI). NIC will only respond to PCI configuration commands. Leakage current is still being consumed. Power states: D0, S0, L1a Target: 16mW
Off (with Vaux)	This is the average power consumption after the system was put in S3 or in S4 states and the adaptor was put in D3 no PME state. Leakage current only is still being consumed if power is connected, else it will be zeroed. Power states: D0(No-PME), Sx, L2 Target: 9mW
Tx1(one SS)	Average power consumption measured while the adaptor is transmitting a packet via one spatial stream. Power states: D0, S0, L0/L1a Target: Low rate: 1600 mW Mid rate: 1400 mW
Tx2(Two SS)	Average power consumption measured while the adaptor is transmitting a packet via two spatial streams. Power states: D0, S0, L0/L1a Targets: Low rate: 2200mW Mid rate: 2030mW High rate: 2100mW
Rx1 (one Rx chain)	Average power consumption measured while the adaptor is Receiving a packet via one Rx chain, the same as in a/g mode Power states: D0, S0, L0/L1a Target: 910mW
Rx2(two Rx chains)	Average power consumption measured while the adaptor is Receiving a packet via two Rx chains, using MRC or MIMO 40 or MIMO 20 Power states: D0, S0, L0/L1a Target: 1400mW

Name	Requirement
Rx3(three Rx chains)	Average power consumption measured while the adaptor is Receiving a packet via two Rx chains, using MRC or MIMO 40 or MIMO 20 Power states: D0, S0, L0/L1a Target: 1760mW
Idle associated (MM01)	Idle associated average power consumption: while station is connected to the AP and NIC PSP is set to “maximum battery life”. There is no network traffic and the station is not busy doing radar detection algorithm per AP command. The station wakes up once in a while to check if any data is waiting. We assumed scan occurs infrequently used for MobileMark 2002 Power states: D0, S0, L1a Target : 25mW
Idle non associated	Idle non-associated average power consumption: while station is re-scanning once in a while (see details in the PM SAS), and NIC PSP is set to “maximum battery life”. assumptions: No Scan Power states: D0, S0, L1a Target : 24mW
MM05 WB	Assuming the use of third-party AP product; station is connected to the AP and Downloads 4 Web pages per minute (every 15 seconds), each page is 150KB in size. Target:27mW
RF Kill	The average power consumption after the user requested (via SW GUI or HW button) to stop RF transmissions. RF Kill HW/SW enabled (active) Power states: D0, S0, L1a Target: 16mW
WoWLAN (D3 with	This is the average power consumption after the system was put in S3 state and the adaptor was put in D3 with PME state (WoWLAN no AP-Assist). Power states: D3 (With PME), S3/4, Lx->L1 Target: 23mW
S0-Hx / M0, Mla, Rx	This is the average power consumption while AMT is taking over NIC in Hx, actively recieving Target: 640mW

Name	Requirement
S0-Hx / M0, Mla, Tx	This is the average power consumption while AMT is taking over NIC in Hx, actively transmitting Target: 1110mW
S0-Hx / M0, MLs	This is the average power consumption while AMT is taking over NIC in Hx, idle between Tx and Rx Target: 27mW
S0 / M0-idle Driver disabled	This is the average power consumption while Intel® AMT is taking over NIC and the Host driver is disabled (Note: 4965AGN upper MAC runs on host) Target: 15mW
S0 / M0-idle Driver enabled	This is the average power consumption while Intel® AMT is taking over NIC and the Host driver enabled Target: 23mW

Note: The maximum power drain by a MiniCard allowed by the spec from 3.3Vmain is 1000mA average for any 10ms and 750mA average for any 1000ms, and 500mA and 375mA from 1.5V, respectively. (Taken from the MiniCard Spec v1.0a)

4.5 MiniCard DC Specifications

The MiniCard requires 1.5 V +/-5% and 3.3 V +/- 9 % for proper operation with a maximum power under 2.5W for full operation.

4.6 WLAN Indicator DC Specification / Functional Description

The LED_WLAN# input signal from Pin 44 indicates wireless LAN association. If the MiniCard is associated with an AP or another client, then the LED displays a solid on (high). If the MiniCard is not associated, yet powered, the LED displays a slow blink. If the MiniCard is not powered, then the LED is off.

LED_WLAN# input signal is active low and is intended to drive a system-mounted LED indicator. This signal is capable of:

- Minimum Sinking Current to ground = 9.0 mA
- Absolute Maximum Sinking Current to ground = 16.0 mA (recommendation: should not exceed 14.0 mA)

The 4965AGN hardware supports WoWLAN (using the Wake# signal on Pin 1), whereby the LED must be activated in S3 state.

- If the Driver is not alive yet, and the uCode is not in the WoWLAN state, then the LED will be Off - with not RXON command from the Driver, the MiniCard will not activate the Radio. Therefore, no matter what had happened during the previous boot cycle, the radio and LED will be off until the driver loads, and then only will the driver use the last configuration based on the registry settings.

The LED has four defined states as shown in Table 4.

Table 5: 4965AGN Hardware LED Status

LED State	Description	Definition	Characteristics

LED State	Description	Definition	Characteristics
OFF	Not powered/disabled	The LED does not emit any light.	
ON	Powered/associated and authenticated but not transmitting or receiving	The LED emits light in a stable non-flashing state.	
Slow Blink	Powered but not associated or authenticated; searching	The LED flashes at a steady but slow rate.	250+/-25% msec ON period; 0.2 +/- 25% Hz Blink Rate
Intermittent Blink	Activity is proportional to transmitting/receiving speed	The LED flashes intermittently, proportional to activity on the interface.	50% duty cycle; 3Hz minimum Blink Rate; 20 Hz maximum Blink Rate

4.7 Hardware RF Disable DC Specifications and Functional Description

The W_Disable# input signal on Pin 20 of the MiniCard system connector allows for use of the hardware to disable the RF portions of the MiniCard. Implementing a mechanical switch is not required; therefore, the card needs to deal with a high impedance input signal via a pull-up transistor or another suitable alternative solution.

The W_Disable# 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 platform clock. All transients resulting from mechanical switches need to be de-bounced by platform circuitry. When the W_Disable# signal is asserted, the power amplifier is shut down. When the W_Disable# is not asserted or is in a high impedance state, the radio may transmit.

This signal is capable of:

- a. Minimum Sink Current to ground = 1 mA per card

Note: The 1mA value is taken from the PCI Expresss MiniCard electrical Specification. However, the Kedron case should be able to drive a much lower current when the W_Disable# signal is active low (~50uA).

In normal operation, the add-in card must cease any transmissions within one second after the W_Disable# signal is asserted. The hardware must assure that the disable operation (Disable within the specified time) is not software dependent. The MiniCard should resume normal operation within one second of de-assertion of the W_Disable# signal. Due to the potential of a software disable state, the combination of both the software state and assertion state must be determined before resuming normal operation. When the system is not at S0, the MiniCard remains disabled until the system completes **Resume** and **Wireless Disable** is inactive.

The system is required to assure that W_Disable# be in a deterministic state (asserted or de-asserted) whenever power is applied to the MiniCard (i.e., whenever either +3.3V or +3.3Vaux is present).

When the W_Disable# signal is asserted, it will directly shut down the Power Amplifier.

If the uCode is in sleep mode, then the Power Amp will be disabled immediately.

If the uCode is still alive, then there will be a delay of ~ 100msec (Silicon timer) in order to provide the uCode some time.

Even if the driver has been disabled, the Power Amp can be disabled.

The hardware-disabling feature, independent of firmware, is a customer requirement.

This signal is implemented using an Input/Output (I/O) pin on the MAC with the software driver polling the pin for a constant state. If the signal is detected at the edge connector as logic 0 (low), the driver will issue a PHY_OFF command, which in turn shuts the radio down, preventing any transmit or receive activity from occurring.

The operation of the signal is:

- Float = Radio is on.
- Off (Active low: Vil = 0.0v [+/-0.3]) = Radio transmitter is turned off and incapable of transmitting unless the user performs some action to change the state of the radio (such as manually changing the switch).

Note: The control of the radio transmitter is an AND of the software and hardware mechanisms. The radio transmitter shall remain disabled unless both the software and hardware settings are enabled for the radio transmitter.

Table 6: 4965AGN Hardware RF Disable Logic

Software Setting	Hardware Switch	Radio Transmitter Function
Enabled	Enabled/Float	Enabled
Enabled	Disabled/Low	Disabled
Disabled	Enabled/Float	Disabled
Disabled	Disabled/Low	Disabled

4.8 Auxiliary Signal (PERST#, WAKE#) DC Specifications

For more information, please refer to the PCI Express Card Electromechanical Specification, Rev. 1.0a.

4.9 Bluetooth* AC Specifications

Intel® Wireless Coexistence System Signal Timing Specification

Please refer to the RS - Intel® Wireless Coexistence System (WCS) - Phase II Specification for the following:

- BT_Priority Signal Timing Diagram
- BT_Priority Signal Timing Thresholds
- 4965AGN hardware Channel Number Interface Start Sequence
- Basic WLAN and Bluetooth* Timing

Bluetooth* wireless technology priority information and Network Connection hardware channel information are exchanged over a two-wire interface: BT_Data and BT_CHCLK. The Priority signal and the Channel Clock signal are multiplexed on the same physical interface (BT_CHCLK) with each signal transmitted in real time in a coordinated manner. The Channel Data signal (BT_Data) transfers the current NIC channel in use and indicates long-term channel inactivity (e.g., sleep modes and idle state) to the Bluetooth* module.

Bluetooth* wireless technology uses channel number information from the NIC network connection to avoid all non-critical packet transmissions on the NIC channel currently in use. Priority packet transmissions (connection establishment/maintenance, HID traffic, etc.) are transmitted on the NIC channel after asserting the Priority signal. The NIC module distinguishes the Priority signal from the Channel Clock signal by its unsolicited high state on the BT_CHCLK line.

Hardware Signaling Method: This method of Wireless Coexistence utilizes a two-wire GPIO mechanism (Pin 3: BT_Data and Pin 5: BT_CHCLK) for signaling.

Hybrid Signaling Method: This method of Wireless Coexistence utilizes only Pin 3: BT_Data for communication. The channel data sent by the 4965AGN hardware is sent via a software mechanism between the 4965AGN driver and the Bluetooth* stack.

Details on WCS Auto-Detect method for determining whether to run in HW or Hybrid mode: Pin 3 is set High when the MiniCard scans or associates (During a scan, all channels are impacted). If the WCS solution is Hardware, then the BT module will respond with 5 pulses on Pin 5 within 50 usec (if the 4965AGN MiniCard confirms this timing, then it will run in Hardware mode. If not, then the 4965AGN MiniCard runs in Hybrid mode.

4.10 Auxiliary Signal (PERST#, WAKE#, REFCLK) AC Specifications

For more information, please refer to the PCI Express Card Electromechanical Specification, Rev 1.1.

5 Rates

The 4965AGN MIMO receiver will support a subset of the combinations of DSP GI (Guard interval), MCS (Modulation Coding Scheme) and BW (Bandwidth) defined in 802.11n.

In the new standard the SISO rates are not equal to the legacy rates (see tables below).

Table 7: Rate Dependent Parameters for Mandatory 20 MHz, NSS=1 Modes

MCS Index	Data rate (Mbps)	
	800ns GI	400ns GI1
0	6.5	7.2
1	13.0	14.4
2	19.5	21.7
3	26.0	28.9
4	39.0	43.3
5	52.0	57.8
6	58.5	65.0
7	65.0	72.2

Table 8: Rate Dependent Parameters for Optional 20 MHz, NSS=2 Modes

MCS Index	Data rate (Mbps)	
	800ns GI	400ns GI
8	13.0	14.444
9	26.0	28.889
10	39.0	43.333
11	52.0	57.778
12	78.0	86.667
13	104.0	115.556
14	117.0	130.000
15	130.0	144.444

Table 9: Rate Dependent Parameters for Optional 40 MHz, NSS=1 Modes

MCS Index	Data rate (Mbps)	
	800ns GI	400ns GI
8	13.0	14.444
9	26.0	28.889
10	39.0	43.333
11	52.0	57.778
12	78.0	86.667
13	104.0	115.556
14	117.0	130.000
15	130.0	144.444

Table 10: Rate Dependent Parameters for Optional 40 MHz, NSS=2 Modes

MCS Index	Data rate (Mbps)	
	800 ns GI	400ns GI
8	27.0	30.0
9	54.0	60.0
10	81.0	90.0
11	108.0	120.0
12	162.0	180.0
13	216.0	240.0
14	243.0	270.0
15	270.0	300.0

Table 11: Rate Dependent Parameters for Optional 40 MHz HT duplicate mode, NSS=1

MCS Index	Data rate (Mbps)	
	800 ns GI	400ns GI
32	6.0	6.7

Table 12: Modulation and Channel Data Rates

Data Rate (Mbps)	Modulation	Data Rate (Mbps)	Modulation
1	DBPSK	6	OFDM
2	DQPSK	9	OFDM
5.5	CCK	12	OFDM
11	CCK	18	OFDM
		24	OFDM
		36	OFDM
		48	OFDM
		54	OFDM

6 Receiver Sensitivity

The tables below show the receiver sensitivity specification with corresponding band/data and rate/modulation information for the 4965AGN hardware.

Table 13: 4965AGN Sensitivity: BW= 20MHZ, GI = 800 nsec, 2.4 GHz and 4.9-5.826 GHz Bands

4965AGN Sensitivity BW= 20MHZ, GI = 800 nsec, 2.4 GHz and 4.9-5.826 GHz Bands			
		2x2 Channel AWGN	
MCS	Rate	Sensitivity (dBm)	
BPSK - ½	13	-90	
QPSK - ½	26	-87	
QPSK - ¾	39	-85	
16 QAM -1/2	52	-82	
16 QAM -3/4	78	-79	
64 QAM - 2/3	104	-76	
64 QAM - ¾	117	-73	
64 QAM - 5/6	130	-72	

Table 14: 4965AGN Sensitivity: BW= 20MHZ, GI = 400 nsec, 2.4 GHz and 4.9-5.826 GHz Bands

4965AGN Sensitivity BW= 20MHZ, GI = 400 nsec, 2.4 GHz and 4.9-5.826 GHz Bands			
		2x2 Channel AWGN	
MCS	Rate	Sensitivity (dBm)	
64 QAM - 5/6	144.44	-71	

Table 15: 4965AGN Sensitivity: BW=40 MHz, GI = 800 nsec, 4.9-5.826 GHz Bands

4965AGN Sensitivity BW=40 MHz, GI = 800 nsec, 4.9-5.826 GHz Bands			
		2x2 Channel AWGN	
MCS	Rate	Sensitivity (dBm)	
BPSK - 1/2	27	-87	
QPSK - 1/2	54	-84	
QPSK - 3/4	81	-82	
16 QAM -1/2	108	-79	
16 QAM -3/4	162	-76	
64 QAM - 2/3	216	-73	
64 QAM - 3/4	243	-70	
64 QAM - 5/6	270	-69	

Table 16: Kedron Sensitivity: BW=40 MHz, GI = 400 nsec, 4.9-5.826 GHz Bands

4965AGN Sensitivity BW=40 MHz, GI = 400 nsec, 4.9-5.826 GHz Bands			
		2x2 Channel AWGN	
MCS	Rate	Sensitivity (dBm)	
64 QAM - 5/6	300	-68	

Table 17: Kedron legacy Sensitivity: BW=20 MHz, GI = 800 nsec, 2.4 GHz and 4.9-5.826 GHz Bands

4965AGN legacy Sensitivity BW=20 MHz, GI = 800 nsec, 2.4 GHz and 4.9-5.826 GHz Bands			
		1x1 Channel AWGN	1x2 MRC Channel AWGN
MCS	Rate	Sensitivity (dBm)	
BPSK - 1/2	6	-90	-93
BPSK – 3/4	9	-89	-91
QPSK - 1/2	12	-87	-90
QPSK - 3/4	18	-85	-87
16 QAM -1/2	24	-82	-85
16 QAM -3/4	36	-79	-82
64 QAM - 2/3	48	-76	-79
64 QAM - 3/4	54	-74	-76

7 Antenna Port Impedance

Nominal antenna port impedance specification is 50 ohms for the 4965AGN hardware.

8 Mechanical Specifications

This section provides information about the mechanical specifications.

8.1 MiniCard Mass and Dimensions

The 4965AGN hardware is designed to comply with the dimensions specified in the PCI Express MiniCard Electromechanical Specification. The dimensions below include the top (which includes the shield) and side views.

Figure 2: Top View of MiniCard with Shield and Antennas

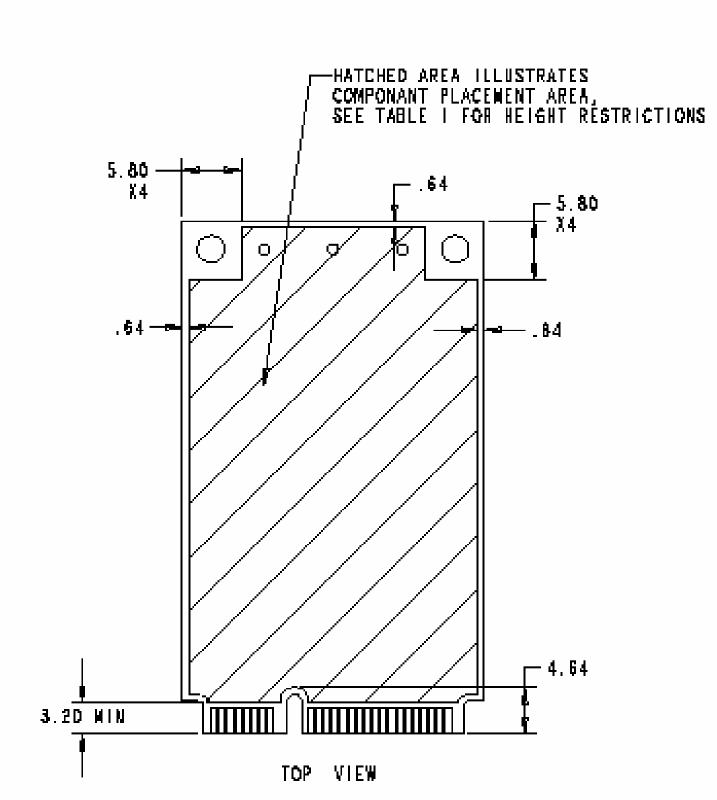


Figure 3: Top View / Side MiniCard Dimensions

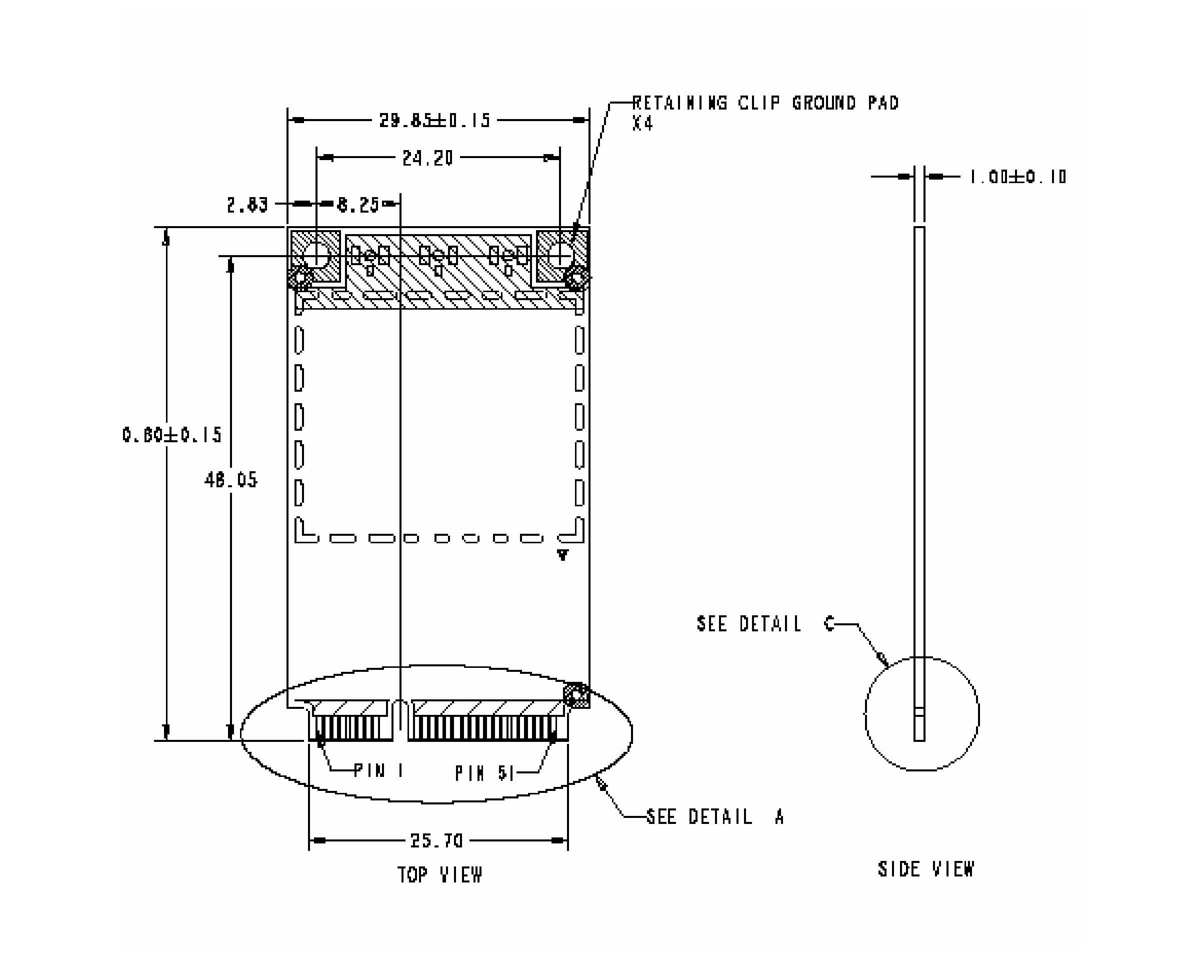
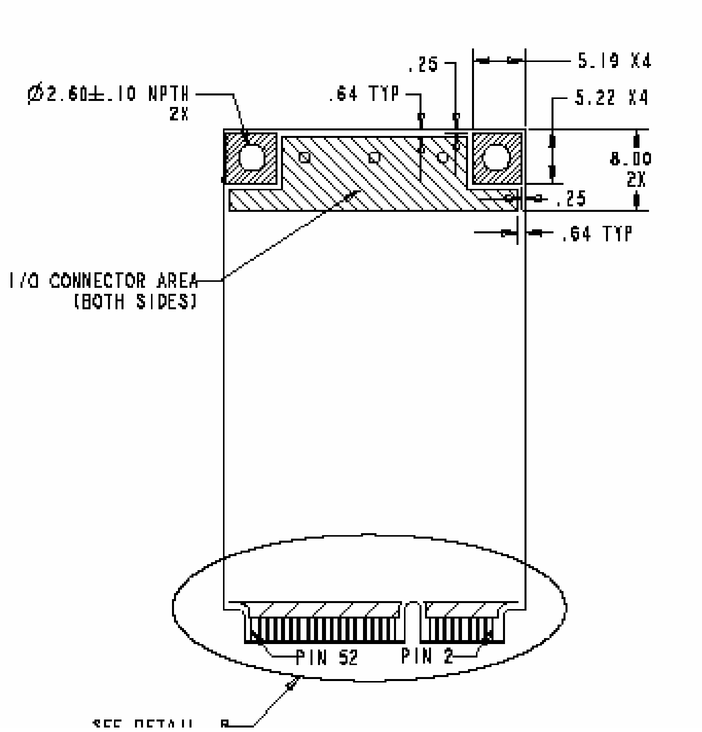


Figure 4: Bottom View MiniCard Dimensions



Unless otherwise specified, interpret dimensions and tolerances in accordance with American Society of Mechanical Engineers (ASME) Y14.5m-1994. Dimensions are in millimeters.

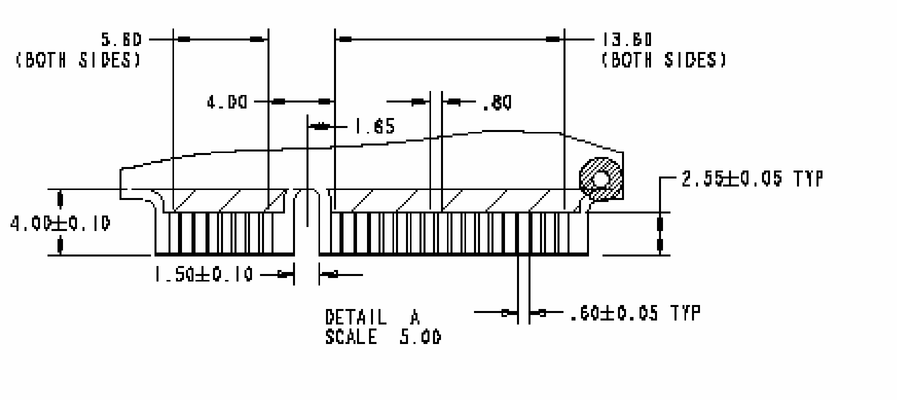
8.2 Antenna Receptacles

The Hirose U.FL-R-SMT connector will be used on the 4965AGN hardware to mate with cable connector U.FL-LP-066.

8.3 Connector Interface

The diagram in Figure 4 is excerpted from the PCI Express MiniCard Electromechanical Specification, Rev. 1.1, published by the PCI-SIG, of which Intel Corporation is a member. It contains the mechanical information for the MiniCard edge connector. The following sections of this document detail Intel's deviations from this specification to improve the contact reliability for our customers. Measurement references below are in millimeters.

Figure 5: MiniCard Edge Connector



9 References

Document Name	Location
Intel® PRO/Wireless Antenna Specification	Contact Intel Field Office
Intel® PRO/Wireless Antenna Vendor List	Contact Intel Field Office
Wireless LAN MAC and PHY Specifications, 802.11b	http://standards.ieee.org/getieee802/download/802.11b-1999_Cor1-2001.pdf
Wireless LAN MAC and PHY Specifications, 802.11g	http://standards.ieee.org/getieee802
Wireless LAN MAC and PHY Specifications, 802.11a	http://standards.ieee.org/getieee802
PCI Express Base Specification, Rev 1.1	http://www.pcisig.com/specifications/pciexpress
PCI Express Card Electromechanical Specification, Rev 1.1	http://www.pcisig.com/specifications/pciexpress
PCI Express MiniCard Electromechanical Specification, Rev 1.1	http://www.pcisig.com/specifications/pciexpress
PCI Local Bus Specification Rev. 2.3	http://www.pcisig.com/specifications/conventional/conventional_pci
PCI Bus Power Management Interface Specification Rev 1.1	http://www.pcisig.com/specifications/conventional/pci_bus_power_management_interface
Advanced Configuration and Power Interface Version 3.0	http://www.acpi.info/spec.htm
Microsoft Hardware Device Class Power Management Specification	http://www.microsoft.com/whdc/hwdev/resources/specs/pmref/default.mspx
Hirose U.FL antennae receptacle	http://www.hirose.co.jp/cat2002e/300/e32119372.pdf
Intel® Centrino® Mobile Technology Wireless Design Guide	Document #12674
Intel® PRO/Wireless Kedron Network Connection Software Technical Product Specification, Rev 3.0	To Be published
RS - Intel® Wireless Coexistence System (WCS) - Phase II Specification, Rev 0.95	Document #15619
RS - Intel® Wireless Coexistence System Specification, Rev 1.0	Document #13398
Santa Rosa Design Guide	Document #20517

10 Acronyms and Definitions

The following list defines key terms and acronyms used in this document.

Term	Definition
ACPI	Advanced Configuration Power Interface
ADC	Analog-to-Digital Converter
AES	Advanced Encryption Standard
AGC	Automatic Gain Control
AMT	Active Management Technology
AP	Access Point
ARC	Advanced RISC Computing (Upper MAC)
ASME	American Society of Mechanical Engineers
BPF	Band Pass Filter
CCK	Complementary Code Keying
DAC	Digital-to-Analog Converter
DBPSK	Differential Bi-phase Shift Keying
DC	Direct Current
DMA	Direct Memory Access
DQPSK	Differential Quadrature Phase Shift Keying
DSP	Digital Signal Processor
DSSS	Direct Sequence Spread Spectrum
D - States	ACPI (Advanced Control and Power Interface) Peripheral Device power states
ETSI	European Telecommunication Standards Institute
GI	Guard Interval
GND	Ground Signal
GUI	Graphical User Interface
HID	Human Interface Devices
IC	Integrated Circuit
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
I/O	Input/Output
I/Q	In-Phase/Quadrature Phase
ISM	Industrial, Scientific, and Medical (Band)

Term	Definition
LED	Light Emitting Diode (Signal)
LNA	Low Noise Amplifier
L - States	ASPM (Active State Power Management). Link States is a hardware based capability to manage the PCI Express Link between the root device on the system board and the MiniCard.
MAC	Media Access Control
MCS	Modulation Coding Scheme
Mbps	Megabits Per Second
NC	Not Connected (Signal)
NIC	Network Interface Card
OFDM	Orthogonal Frequency Division Multiplexing
PA	Power Amplifier
PCI	Peripheral Component Interconnect
PCI Express MiniCard	PCI Express MiniCard mobile form factor
PHY	Physical Layer
PLCP	Physical Layer Convergence Protocol
PLL	Phase Locked Loop
PSP	Power Save Polling
QoS	Quality of Service
RF	Radio Frequency
RISC	Reduced Instruction Set Computing
Rx	Receive
SISO	Single Input, Single Output. Antenna implementation using a single antenna at a given time versus a MIMO (Multiple Input, Multiple Output) antenna configuration
SKU	Stock Keeping Unit
SRAM	Static Random Access Memory
TBTT	Target Beacon Transmission Time
Tx	Transmit
VCO	Voltage Controlled Oscillator
Wake-up	A mechanism used by a component to request the reapplication of main power when in the L2 Link state. Two such mechanisms are defined in the PCIe Base Specification: Beacon and WAKE#. This specification requires the use of WAKE# for the MiniCard and system board that supports wakeup functionality.
WCS	Wireless Coexistence System for Bluetooth*

Term	Definition
WEP	Wired Equivalent Privacy
WFA	Wi-Fi Alliance*
WHQL	(Microsoft) Windows Hardware Quality Labs
Wi-Fi	Wireless Fidelity
WLAN	Wireless Local Area Network
WoWLAN	Wake on Wireless LAN (See Wake-up)
XTL	40-MHz Crystal

Bluetooth Module

GUBTCR42M

DESIGN GUIDE

Preliminary Version

September, 2005

1. Device Overall Description

Project Name: GUBTCR42M

The GUBTCR42M is designed to provide Bluetooth wireless functions on a Notebook internal form Factor card. The Bluetooth function is based on CSR BlueCore04-External Single Chip, which implements the full speed class 2 Bluetooth operation with full 7 slave piconet support. The Bluetooth function of GUBTCR42M to host system is USB compliant with USB V2.0 standard interface. The GUBTCR42M is fully support Bluetooth V1.1, V1.2 , especially V2.0 Enhanced Data Rate. The Bluetooth application program could be used in IVT or Toshiba software.

1.1 Scope

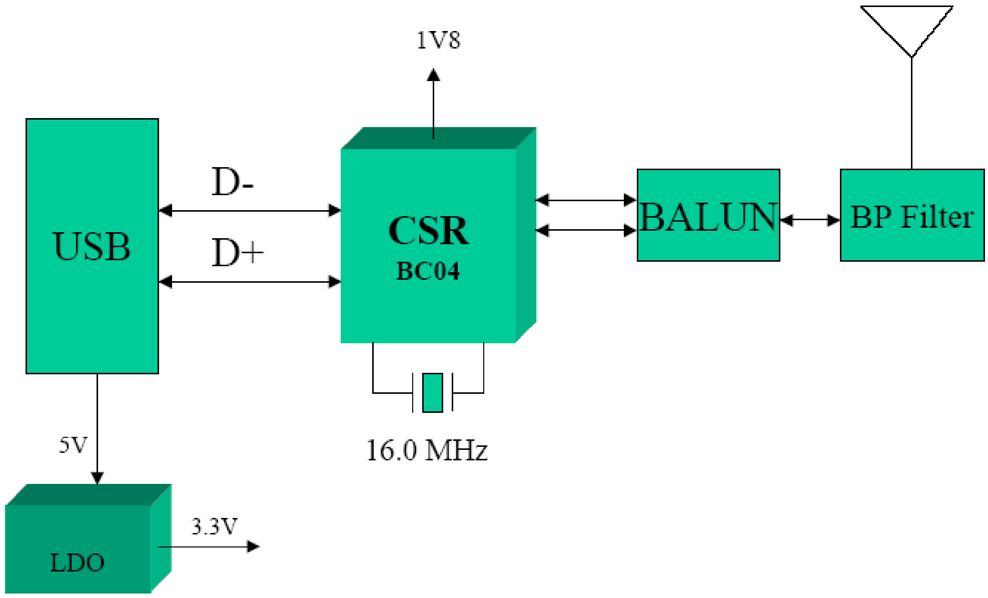
- Bluetooth v2.0+EDR compliant
- Full speed USB v2.0 Interface
- Bluetooth wireless access up to a radius of 32.8 feet (10 Meters)
- Connect up to 7 different enabled Bluetooth devices
- Encryption and authentication ensure safe, secure communications
- Low power consumption

1.2 Bluetooth Specification :

- Bluetooth compatible with Bluetooth specification version 2.0.
- Fully compliant to Bluetooth SIG (BQB) compatibility testing.
- Supported profiles:
- A2DP (Adv. Audio Dist. Profile),
- BIP (Basic Imaging Profile),
- DUN (Dial Up Networking Profile),
- FAX (Fax Profile),
- FTP (File Transfer Profile),
- GOEP (Generic Object Exchange Profile),
- HCRP (Hard Copy Replacement Profile),
- HID (Human Interface Device Profile),
- HSP (Headset Profile),
- OPP (Object Push Profile),
- PAN (Personal Area Network Profile),
- SDAP (Service Discovery Application Profile),
- SPP (Serial Port Profile),
- SYNCH (Synchronization Profile),
- Software & OS support
- Microsoft Windows 98SE, Windows ME/2000 /XP, Mac OS 10.2.8 and above

2. Electrical Specification

2.1 Hardware Block Diagram



2.2 Bluetooth Power Consumption

Supply Voltage : 3.3Volt	Current
Idle Mode	40mA
TX Continuous	63mA
RX	40mA

※ (Varies depending on use environment)

2.3 Channel Assignment

Country	Freq. range	RF Channel
Europe & USA	2400~2483.5MHz	Freq.= 2402 + k MHz k=0~78
Japan	2400~2483.5MHz	Freq.= 2402 + k MHz k=0~78
Spain	2445~2475MHz	Freq.= 2449 + k MHz k=0~22
France	2446.5~2483.5MHz	Freq.= 2454 + k MHz k=0~22

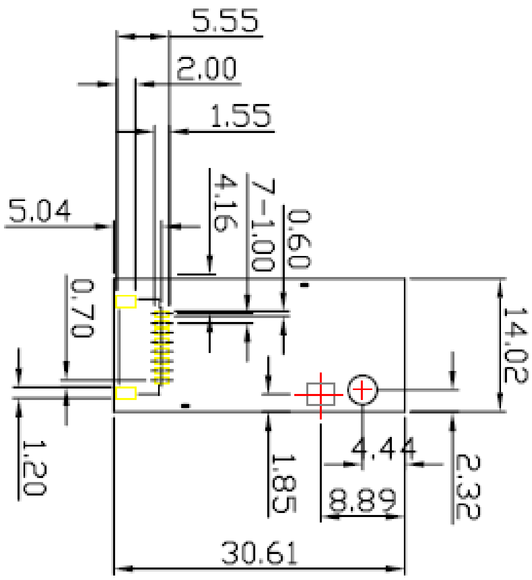
2.4 Bluetooth Hardware Requirements

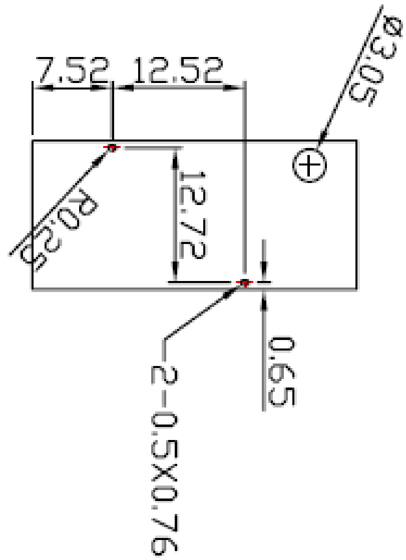
Operation Voltage	3.3V / 1.8V
Frequency Range	2.400---2.4835 GHz
Antenna Load	50 Ohm
Receive Sensitivity	–79 +/- 1 dBm@0.1% BER
Bluetooth TX Power	2 dBm typical (maximum 4dBm @class 2)
Working Range	10 meters at 0 dBm (class 2)
Bluetooth Standard	Compliant with Bluetooth standard v2.0
Pico Net support	1 master to 7 slaves
RF Carriers	79 channels of 1 MHz BW
Security	Full support of Bluetooth security provisions including hardware support for full length 128 bit encryption keys.
Host Interface (USB)	USB specification 2.0 compliant

3. Mechanical Specification

PCB Dimension (W x L x H): 30.61mm x 14.02mm x 0.8mm +/-0.1mm)

Module Height with insulator on both side: 3.9 +/- 0.15 mm



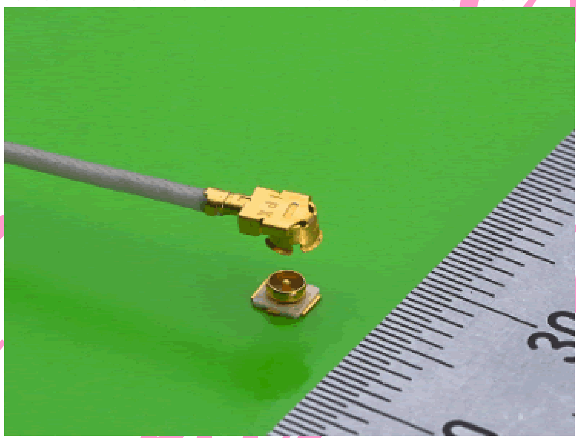


4. Connector Specification

4.1 Antenna Connector

- SMT Ultra Miniature Coax Connector, I-PEX, 20279-001E-01 or compliance

Wi-Fi IEEE802.11a/b & Bluethooth Wireless has been released from I-PEX.



- Key Features

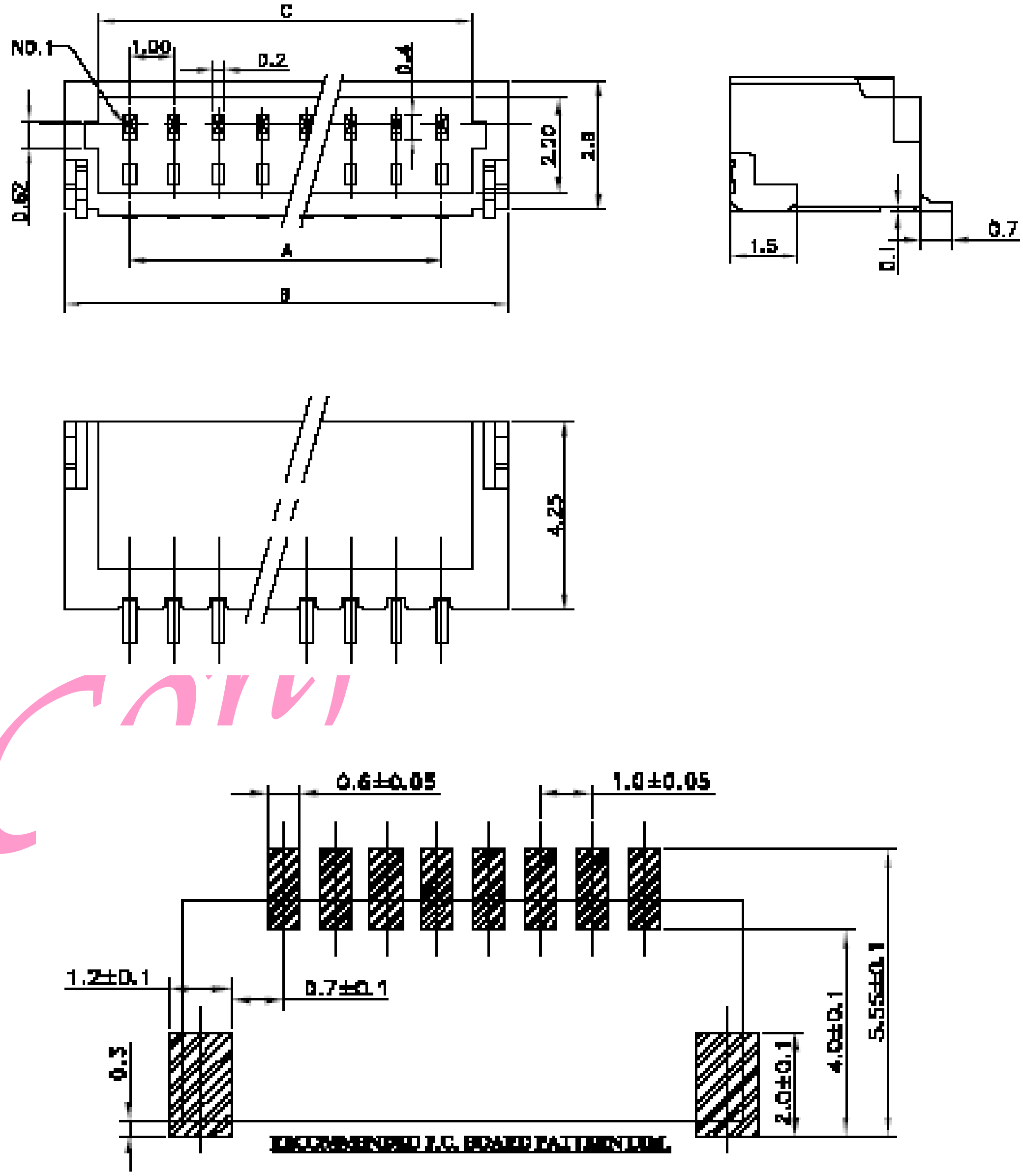
  Smallest coax connectors in the world!
  SMT Receptacle & Mating Plug Cable Connector
  Low Profile: 2.5mm MAX. Mating Height
  Supports wide range of teflon coated coax cable with .8mm to 1.8mm O.D.'s, single and double shield
  Applicable for Wi-Fi IEEE802.11a/b & Bluetooth Wireless
  Supports Dual Band 3-6 GHz
  Easy Cable Termination by "i-FIT" ® Technology
  Cable ass'y Fixture & Plug Extraction tools available

- Specification

  Temperature Range: -40?C ~ +90?C
  Frequency: 3GHz, VSWR: 1.3 MAX. 5GHz, VSWR 1.5 typical
  Insertion loss: -1.3dB typical at 5 GHz, 150mm length
  Characteristic Impedance: 50 ohm (Nominal)
  Voltage Rating: AC60V
  Withstanding Voltage: AC200V
  Insulation Resistance: 500M-ohm MIN. @DC100V
  Contact Resistance: 20m-ohm max signal and 10m-ohm ground

4.2 Host Interface Connector

- Connector: Kabo(凱帛) Wafer-1.0-1001-0893



Key Specification:

Electrical –

- Rated Voltage: 50V AC,DC
- Rated current: 1A
- Withstand Voltage: 500V AC/minute
- Contact Resistence: 20m Ohm (Max.)
- Insulation resistence: 100M Ohm (Min.)
- Temperature Range: -25。 ~ +85。

Material and Finish –

- Circuits: 02 ~16,20
- Material High temperature plastic UL94V-0

Dimensional & Ordering Information:

Cir-cuits	Dimension mm			REEL / PCS
	A	B	C	
02	1.0	4.0	2.5	1,000
03	2.0	5.0	3.5	1,000
04	3.0	6.0	4.5	1,000
05	4.0	7.0	5.5	1,000
06	5.0	8.0	6.5	1,000
07	6.0	9.0	7.5	1,000
08	7.0	10.0	8.5	1,000
09	8.0	11.0	9.5	1,000
10	9.0	12.0	10.5	1,000
11	10.0	13.0	11.5	1,000
12	11.0	14.0	12.5	1,000
13	12.0	15.0	13.5	1,000
14	13.0	16.0	14.5	1,000
15	14.0	17.0	15.5	1,000
16	15.0	18.0	16.5	1,000
20	19.0	22.0	20.5	1,000

5. Design Comments

This parts is intended to provide some design references for implementing this module into the Notebook system.

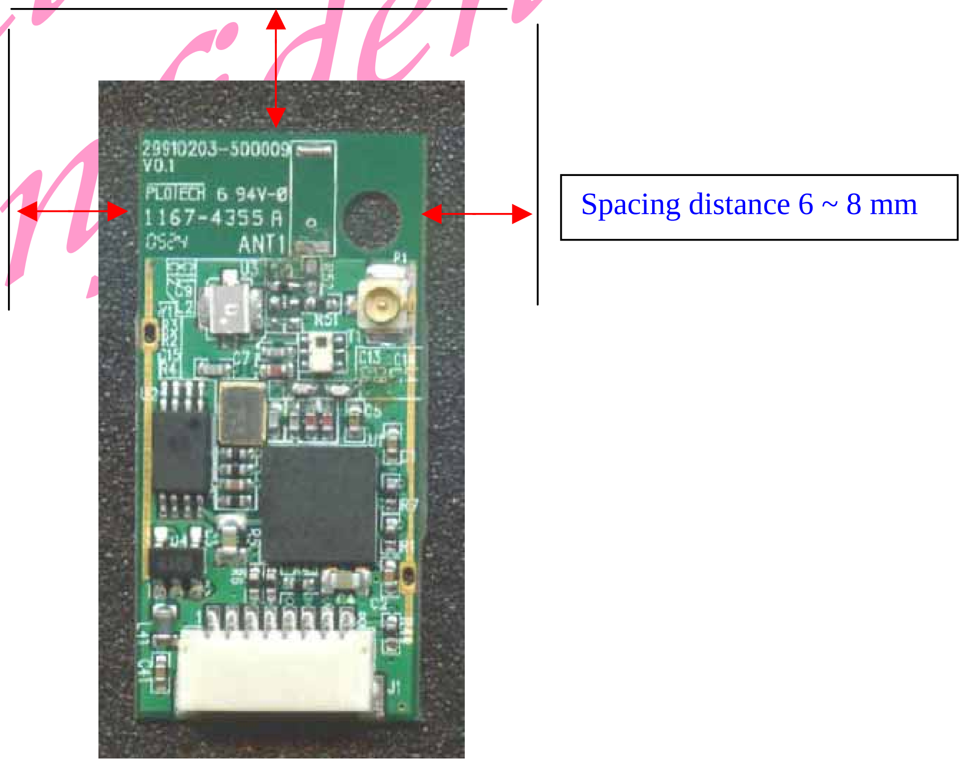
(I) Interferrence Consideration

- Antenna area should be kept away from the following interferring factors:

1. CPU
2. Heating-Sink
3. High frequency clock parts

- Antenna Spacing

Recommended that the antenna area should have 6 ~ 8 mm spacing distance without any conducting material like metal , electrical components…,etc.



- Bluetooth antenna placement design with WLAN in the same system

In the cause of avoiding the interferring between Bluetooth and WLAN, Bluetooth antenna should have a safety distance away from the WLAN.

※ *Recommended spacing distance is 20 cm. And if the mechanical is unable to fulfill, the distance 15 cm between each other at least is necessarily.*

Appendix A : Host Interface Pinout

Pin #	Signal Name	Description
1	+3.3V ~ +5V	Positive supply for whole module
2	GND	Ground Pin
3	USB_D-	USB Data Minus
4	USB_D+	USB Date Plus
5	LED	BT activity LED indicator
6	Reserved BT_ACTIVE	BT Active indicator output to inform WLAN NIC. Host side should keep NC if not supported.
7	Reserved WLAN_ACTIVE	WLAN active indicator input from WLAN NIC. Host side should keep NC if not supported.
8	BT_ON#	Active Low to enable Bluetooth function. High to disable the function

Appendix B : EDR RF Test Report

- ***TX Mode***

ANRITSU Bluetooth EDR transmitter test results

Date : 20 September 2005
Time : 12:47

Bluetooth address :0x00025bc6967e

Packet type : 2-DH1

TP/TRM/CA/10/C Relative transmitter power test

Relative power : -1.1 dB PASS
Guard interval : 5.00 us PASS

TP/TRM/CA/12/C EDR Differential Phase Encoding test

Total number of symbols : 216
symbols in errors : 0

TP/TRM/CA/11/C EDR Carrier Frequency Stability and Modulation Accuracy test

Carrier frequency stability (wi):-13.8 kHz PASS
DEVM peak : 12 % PASS
DEVM 99% : 10 % PASS
Overall block status : PASS

Payload Block	Freq error (Wi+Wo)kHz	Freq error (Wo)kHz	DEVM RMS %
1	-12.9	0.9	5
2	-11.8	2.0	5
3	-12.6	1.2	5

ANRITSU Bluetooth EDR transmitter test results

Date : 20 September 2005
Time : 12:48

Bluetooth address :0x00025bc6967e

Packet type : 2-DH3

TP/TRM/CA/10/C Relative transmitter power test

Relative power : -1.0 dB PASS
Guard interval : 5.00 us PASS

TP/TRM/CA/12/C EDR Differential Phase Encoding test

Total number of symbols : Not applicable to packet type

symbols in errors : Not applicable to packet type

TP/TRM/CA/11/C EDR Carrier Frequency Stability and Modulation Accuracy test

Carrier frequency stability (wi):-11.3 kHz PASS
DEVM peak : 14 % PASS
DEVM 99% : 11 % PASS
Overall block status : PASS

Payload Block	Freq error (Wi+Wo)kHz	Freq error (Wo)kHz	DEVM RMS %
1	-12.2	-0.9	5
2	-11.9	-0.7	5
3	-13.7	-2.5	5
4	-12.3	-1.1	5
5	-11.6	-0.3	5
6	-11.7	-0.5	6
7	-13.0	-1.7	5
8	-13.4	-2.2	5

ANRITSU Bluetooth EDR transmitter test results

Date : 20 September 2005
Time : 12:48

Bluetooth address :0x00025bc6967e

Packet type : 2-DH5

TP/TRM/CA/10/C Relative transmitter power test

Relative power : -1.0 dB PASS
Guard interval : 5.00 us PASS

TP/TRM/CA/12/C EDR Differential Phase Encoding test

Total number of symbols : Not applicable to packet type
symbols in errors : Not applicable to packet type

TP/TRM/CA/11/C EDR Carrier Frequency Stability and Modulation Accuracy test

Carrier frequency stability (wi):-12.4 kHz PASS
DEVM peak : 14 % PASS
DEVM 99% : 12 % PASS
Overall block status : PASS

Payload Block	Freq error (Wi+Wo)kHz	Freq error (Wo)kHz	DEVM RMS %
1	-11.6	0.8	4
2	-12.1	0.3	5
3	-12.4	-0.0	5
4	-12.5	-0.1	5
5	-12.5	-0.1	5
6	-11.6	0.8	6
7	-12.6	-0.2	5
8	-11.7	0.7	5
9	-13.9	-1.5	5

ANRITSU Bluetooth EDR transmitter test results

Date : 20 September 2005
Time : 12:49

Bluetooth address :0x00025bc6967e

Packet type : 3-DH1

TP/TRM/CA/10/C Relative transmitter power test

Relative power : -1.0 dB PASS
Guard interval : 5.00 us PASS

TP/TRM/CA/12/C EDR Differential Phase Encoding test

Total number of symbols : 216
symbols in errors : 0

TP/TRM/CA/11/C EDR Carrier Frequency Stability and Modulation Accuracy test

Carrier frequency stability (wi):-12.7 kHz PASS
DEVM peak : 11 % PASS
DEVM 99% : 11 % PASS
Overall block status : PASS

Payload Block	Freq error (Wi+Wo)kHz	Freq error (Wo)kHz	DEVM RMS %
1	-12.3	0.4	5

ANRITSU Bluetooth EDR transmitter test results

Date : 20 September 2005
Time : 12:46

Bluetooth address :0x00025bc6967e

Packet type : 3-DH3

TP/TRM/CA/10/C Relative transmitter power test

Relative power : -1.0 dB PASS
Guard interval : 5.00 us PASS

TP/TRM/CA/12/C EDR Differential Phase Encoding test

Total number of symbols : Not applicable to packet type
symbols in errors : Not applicable to packet type

TP/TRM/CA/11/C EDR Carrier Frequency Stability and Modulation Accuracy test

Carrier frequency stability (wi):-12.8 kHz PASS
DEVM peak : 14 % PASS
DEVM 99% : 11 % PASS
Overall block status : PASS

Payload Block	Freq error (Wi+Wo)kHz	Freq error (Wo)kHz	DEVM RMS %
1	-12.0	0.8	5
2	-13.1	-0.3	5
3	-12.6	0.2	5
4	-13.8	-1.0	6

ANRITSU Bluetooth EDR transmitter test results

Date : 20 September 2005
Time : 12:51

Bluetooth address :0x00025bc6967e

Packet type : 3-DH5

TP/TRM/CA/10/C Relative transmitter power test

Relative power : -1.0 dB PASS
Guard interval : 5.00 us PASS

TP/TRM/CA/12/C EDR Differential Phase Encoding test

Total number of symbols : Not applicable to packet type
symbols in errors : Not applicable to packet type

TP/TRM/CA/11/C EDR Carrier Frequency Stability and Modulation Accuracy test

Carrier frequency stability (wi):-12.5 kHz PASS
DEVM peak : 14 % PASS
DEVM 99% : 11 % PASS
Overall block status : PASS

Payload Block	Freq error (Wi+Wo)kHz	Freq error (Wo)kHz	DEVM RMS %
1	-12.2	0.3	5
2	-11.4	1.1	5
3	-12.3	0.2	5
4	-11.5	1.0	6
5	-12.1	0.4	5
6	-12.1	0.4	5
7	-12.3	0.2	5
8	-12.3	0.2	5
9	-12.2	0.3	5

- ***RX Mode***

Test Model: GUBTCR42M
Test Instrument: ANRITSU MT8852A
ANRITSU Bluetooth EDR receiver test results

Frequency	2441 MHz	2441MHz
Modulation	2-DH1	3-DH5
Sensitivity	-82 dBm	-76 dBm