Universal Antenna Module Mechanical Specification

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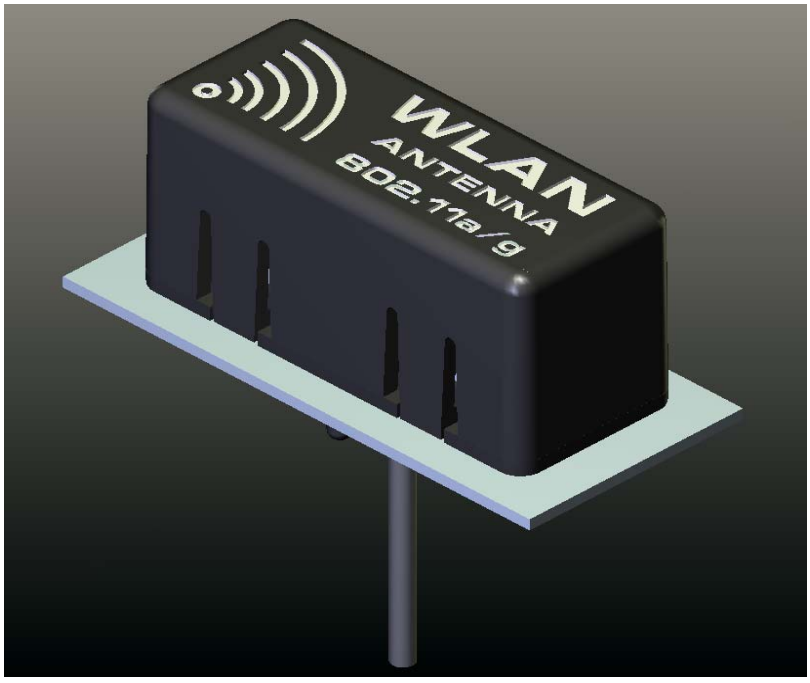

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1 Preface

This document describes the specifications and design recommendations for the development of standardized WLAN antenna modules suitable for implementation into a desktop PC. Such modules are known as Universal Antenna Modules or UAMs.

Integrated antennas have several advantages when compared against externally attached antennas. These advantages may include lower cost, are easily concealable or hidden, do not require the user to attach or configure them resulting in an improved out-of-box experience, and they are not as susceptible to damage or disconnect.

Integrated antennas currently come in a large variety of non-standard shapes and sizes and each antenna seems to have different mounting requirements. In addition, each antenna requires a chassis feed-through hole in different locations for the coaxial cable. These differences make it difficult for a single chassis design to accommodate more than one different antenna efficiently without the addition of many different holes.

To address this problem, this document defines antenna module mechanical requirements for antenna suppliers (i.e. max dimensions and attachment) and mechanical specifications for chassis developers (i.e. mechanical attachment and keep-outs) to allow simple interfacing of an antenna to a chassis. This specification will ensure compatibility between compliant antennas and chassis making it much easier to add wireless into a desktop chassis environment. The specification ensures that any combination of compliant chassis and antenna module will be fully physically compatible with one another for seamless integration.

Environmental compatibility testing should be conducted for all designs arising from use of this specification. Electrical antenna specifications are not included as part of this document. See the supporting documentation section for more information regarding other important design documents.

1.1 Intended Audience

This document is intended to provide detailed, technical information to antenna suppliers, chassis manufacturers, system integrators, and other engineers and technicians who need this level of information. It is specifically *not* intended for general audiences or PC end users.

2 Design Specifications and Online Support

Table 1 lists the specifications applicable to the Universal Antenna Module.

Table 1. Specifications and Design Guidelines

Specification Title	Version, Revision Date, and Ownership	Document Availability:
802.11abg Desktop Antenna Specification	Revision 0.9, July 2005, Intel Corporation	Intel Field Sales
Desktop Antenna Integration Guide for 2005	Revision 0.7, February 2005 Intel Corporation	Intel Field Sales
2005 Desktop Platform Vision Guide		http://www.intel.com/platforms/desktop/vision/index.htm
2005 Desktop Platform Technology Guide		Intel Field Sales
ATX Specification	Revision 2.2, Intel Corporation	http://www.formfactors.org
BTX Specification	Revision 1.0a, Intel Corporation	http://www.formfactors.org
IEEE-802.11	IEEE	http://standards.ieee.org/getieee802/802.11.html

3 Recommended Roles for Suppliers and Integrators

3.1 Chassis Suppliers

The chassis manufacturer should provide the following items:

- Antenna module attachment feature mounting locations (2 places) and respective orientation suitable for good antenna performance
- Appropriate mechanical clearance around the antenna module
- Appropriate bezel material, minimize metal material on bezel
- Routing path to allow coaxial antenna cable to connect to internal WLAN card.
- Chassis marking (optional)
- Sample of chassis is required for validation by Intel.

Please refer to a design example in Section 5.

3.2 Antenna Suppliers

The antenna manufacturer should provide the following items:

- Antenna, cable and attached electrical connector compliant with the 802.11abg Desktop Antenna Specification
- Plastic module with cover and attachment feature to allow antenna assembly to easily attach to chassis.
  Note: Spacing between antenna element and chassis sheet metal is to be determined by antenna supplier based on antenna mounting requirements, however structural requirements must be met.
- Mechanism to attach antenna to plastic module
- Recommended plastics markings and coloring provided in reference CAD drawing, part number should be visible on underside of part.
- Samples of antenna module assemblies are required for validation by Intel.

Please refer to a design example in Section 5.

3.3 System Integrators

The system integrator should provide the following items:

- The system integrator should assemble the system per WLAN card and antenna specifications
- System integrator should test fully assembled system to ensure mechanical compatibility and verify acceptable wireless performance.

4 Universal Antenna Module Specifications

This chapter defines the mechanical (form, fit and function) recommendations for the Universal Antenna Module (UAM) from the perspective of both the antenna manufacturer and chassis manufacturer and is used in conjunction with the 802.11abg Desktop Antenna Specification. Key features of the UAM include maximum physical module dimensions, chassis keep-out zones, definition of mounting hole and attachment features, and a routing path between the antenna module and the PCI* or PCI Express* WLAN card. A compliant antenna module can be used in any chassis design that supports these key features. Figure 1 shows a mechanical overview of the UAM and Figure 2, Figure 3 and Figure 4 show the module and antenna element dimensions and chassis attachment requirements.

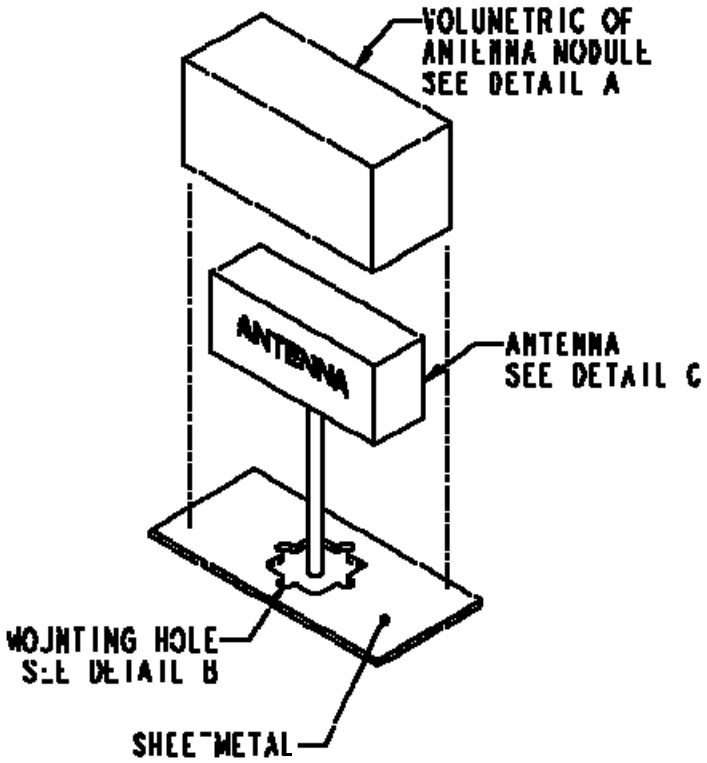

Figure 1. Universal Antenna Module Mechanical Overview

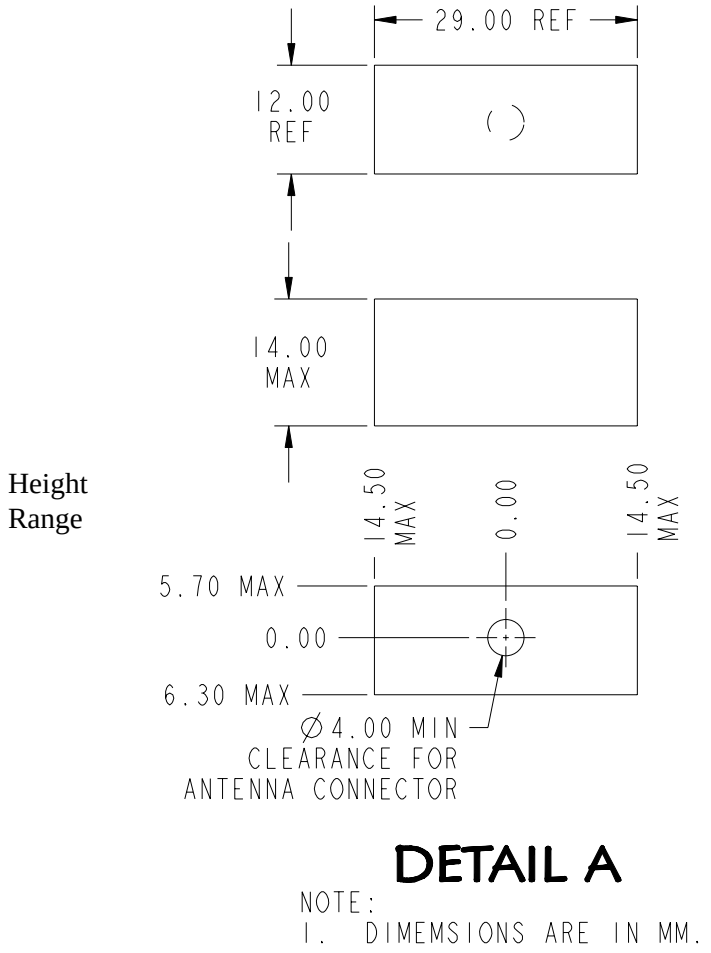

Figure 2. Detail A - Maximum Antenna Module Dimensions

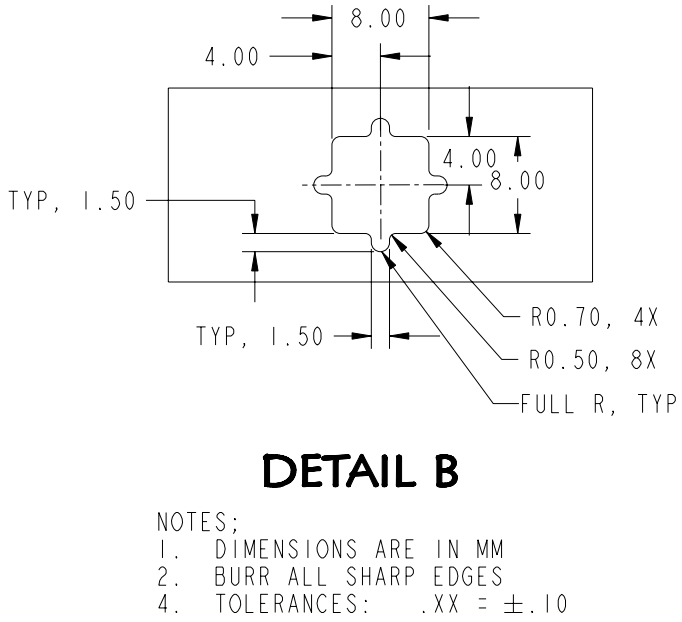

Figure 3. Detail B - Chassis Attachment Sheet Metal (all four keying features)

4.1 For Antenna Manufacturers

This section describes requirements and design guidelines from the perspective of the antenna manufacturer. Figure 2, Figure 3 and Figure 4 define the mechanical antenna element and module dimensions and chassis attachment feature.

4.1.1 Maximum and minimum Antenna Element Dimensions

The maximum antenna element dimensions are defined in Figure 4 relative to the center of the mounting attachment point. Antenna vendors are encouraged to design antennas and plastic housings as small as possible to allow easier assembly into systems in a variety of different locations and orientations.

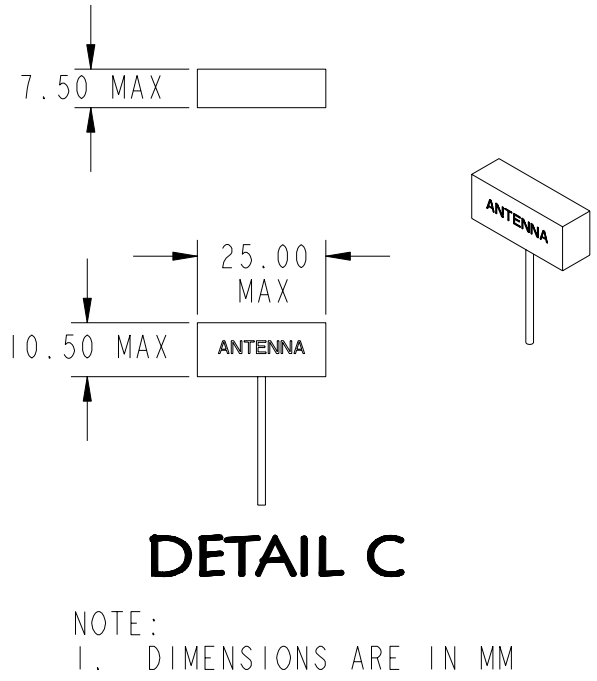

Figure 4. Detail C - Maximum Antenna Element Dimensions (without plastic cover)

4.1.2 Antenna Attachment

The chassis attachment feature is defined in Figure 3 and a sample plastic attachment feature mating to it is shown in Figure 15. An antenna attachment feature should be defined which allows quick assembly and disassembly and firmly locks in place once attached. See Section 5 for a design example.

Attachment features should allow module to securely attach to sheet metal that is 0.8mm thick (most common), but also to less common 1.0mm thick sheet metal.

The attachment feature must not protrude more than 7mm inside the chassis once attached. The chassis supplier is required to provide adequate clearance for the plastic attachment feature and coaxial cable.

Note that only a single keying feature is needed. Please refer to section 4.2.2.

4.1.2.1 Grounding of Antenna

To ensure simplicity and universality of the antenna module, the antenna module should not require or expect that it be grounded to the sheet metal surface of a chassis. The mounting area on the chassis can not be expected to be free and clear of paint or other non-conductive material making it impossible to ensure consistent grounding and performance in all systems.

4.1.3 Antenna Connectors

The plastic aperture of the antenna module should be designed to allow assembly of the most common antenna connectors including the Hirose* U.FL connector, MMCX or equivalent. Refer to Appendix A for dimensions.

4.1.4 Antenna Module Cover

A plastic module cover is required to ensure protection of a fragile antenna and for professional look where the antenna will be visible. Refer to the UAM Markings section below for details on product markings which may be required on this cover.

4.1.5 Material Considerations

Some antennas are subject to de-tuning or resonance shifting when located closely to some types of plastics and other materials. Adhere to common practices when designing the plastic casing and ensure through testing that performance specifications are met. Performance specifications of the antenna must be met with the antenna mounted within the plastic assembly (including the plastic cover) and installed onto a representative chassis.

Types of materials that are recommended for use in plastic antenna modules include ABS plastic w/ no carbon. Use of carbon in plastics is not recommended since this may adversely affect the performance of the antenna.

4.1.6 UAM Markings

Markings and colorings will be provided in a reference CAD drawing available to antenna vendors upon request, vendor specific visible markings will not be allowed other than a part number on the underside of the part. See your field sales representative for further information.

4.1.7 Sample Submission

At least 4 sample antennas including plastic housings are required for validation by Intel to ensure compliance with this specification.

4.2 For Chassis Manufacturers

This section describes requirements and design guidelines from the perspective of the chassis manufacturer. Figure 2 and Figure 3 define the mechanical UAM specifications. Compliant chassis will adhere to the definitions of the UAM keep-out zones and mounting-hole recommendations. Compliant UAMs can be used in any chassis design that supports these key features.

4.2.1 Antenna Keep-out

For compliance with this specification, chassis manufacturers are required to provision for the volume of the UAM as represented in Figure 2 relative to the mounting attachment

point and any bezel overlap. Required clearance on the sheet metal is 3mm. One keying feature will simplify the integration process for the system integrators and “vertical only” is recommended, see Figure 6.

If implementing more than one key in the mounting hole, all four are implemented in Figure 5, additional addition clearances will be required. While different antenna types may radiate in different dominant directions, the chassis should prioritize mounting the UAM in the vertical orientation. The vertical orientation is where the longest dimension of the UAM is perpendicular to the floor in the intended chassis configuration. Refer to Figure 5 for a keep-out zone which represents a super-set of all four UAM orientations.

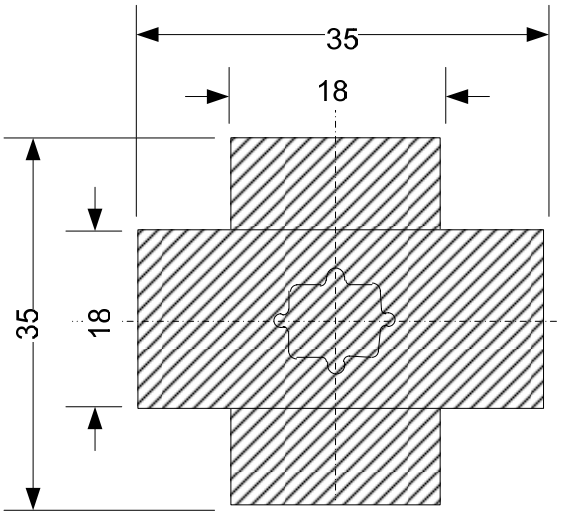

Figure 5. Chassis Keep-out Representing all UAM Orientations

4.2.2 Antenna Attachment

The chassis attachment feature is defined in Figure 3.

The attachment feature of the plastic antenna module must not protrude more than 7mm inside the chassis once attached and adequate clearance for the plastic attachment feature and coaxial cable must be provided.

Figure 6 below shows an example of an optional chassis implementation which controls the installation orientation of the UAM. The UAM plastics have one keying feature along the bottom side of the module when viewing the upright text on the reference design. The chassis sheet metal mounting feature sets the UAM installation orientation(s). In Figure 6, the illustration on the left allows installation of a UAM in the vertical orientation, while the illustration on the right allows installation of the UAM in the horizontal orientation. It is possible to enable up to four orientations but that may add confusion for the system integrator.

The chassis manufacturer is responsible for deburring the mounting feature.

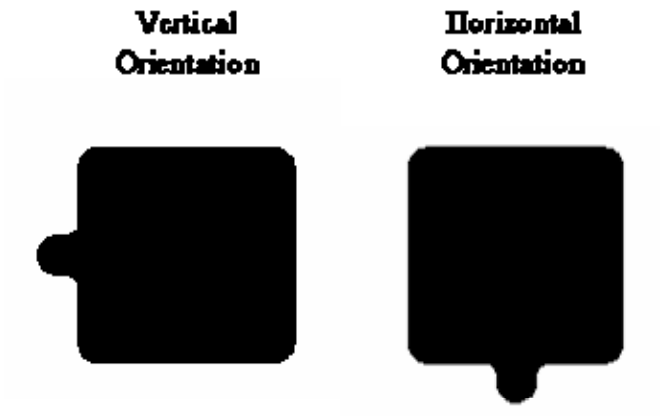

Figure 6. UAM Keying Examples

4.2.3 Design Requirements and Guidelines for Attachment Points

UAM design requirements and guidelines are divided into two parts and are based on BTX/µBTX/pBTX form factors:

- Regulatory Compliance Requirements
- Recommended Performance Guidelines (Prioritized)

Requirements must be implemented to meet regulatory rules regarding peak gain; recommended guidelines should be followed to maximize performance within the requirements. Chassis which meet the requirements and substantially meet the recommended guidelines will be tested upon submission. Intel accepts no liability for the regulatory compliance of systems not submitted for feedback. The requirements are not optional for any form factor though they may be more difficult to meet in bigger form factors. The recommended guidelines are designed to maximize performance and substantial deviation from the guidelines will result in reduced performance. Specific minimum performance metrics may be developed in a later specification revision.

FOR CHASSIS VOLUMES 11L or MORE:

Regulatory Compliance Requirements:

Place the attachment point at least 4.5 cm away from the short edge of the chassis and 2.5 cm away from the long edge of the chassis

Recommended Performance Guidelines (Prioritized):

1	Place the attachment point at least 6.5 cm away from the short edge of a 5.25” or 3.5” drive; do not mount the UAM along the long edge of a standard drivebay or similar metallic structure (i.e. protruding front-panel I/O) within 6.5cm. If the antenna must be mounted along the long edge of a protruding metal structure, first follow the regulatory compliance requirement then attempt to meet the 6.5cm separation guideline.
2	Place the attachment point with the immediate edge of the UAM at least 3.5 cm away from vent hole patterns. Do not mount the UAM over vent holes or other sheet metal apertures
3	Place the attachment point at a location which allows vertical orientation (the orientations are relative to the floor when the chassis is used as intended.) UAM usually performs better in vertical orientations; therefore, this orientation takes priority when only one of the two orientations can be accommodated

FOR CHASSIS VOLUMES LESS THAN 11L :

Regulatory Compliance Requirements:

Place the attachment point at least 4cm away from the short edge of the chassis and 2cm away from the long edge of the chassis

Recommended Performance Guidelines (Prioritized):

1	Chassis with volume 11L or Less which uses laptop style 5.25”drive should keep the UAM at least 2 cm away from the long edge of the drive. For Chassis that uses standard desktop 5.25” and 3’5” drives, follow Guideline #1 for chassis volume 11L or more.
2	Place the center of the attachment point at least 1cm away from vent hole patterns. Do not mount the UAM over vent holes or other sheet metal apertures
3	Place the attachment point at a location which allows vertical orientation (the orientations are relative to the floor when the chassis is used as intended.) UAM usually performs better in vertical orientations; therefore, this orientation takes priority when only one of the two orientations can be accommodated

Note: Ensure that UAMs are only mounted onto metal surfaces outside the chassis as these are specifically designed to utilize the chassis to help improve the range of the antenna. UAMs mounted onto plastic surfaces will perform poorly.

4.2.4 Example Locations of Attachment Points

Design examples in this section can be used as guidelines for antenna attachment locations which will provide good wireless performance as well as flexibility for the system integrator.

The antenna attachment points should be located such that the 24” antenna cable can be routed to a wireless adaptor card in the system. The WLAN card is generally located in the furthest PCI Express* slot from the CPU but may also be located in a mini-card* slot.

Examples of recommended and non-recommended locations for front and rear chassis mounting locations are shown in Figure 7 through Figure 12.

Two UAMs are required per chassis system. One UAM should be placed in the front of the system and one at the rear of the system in either vertical (recommended) or horizontal orientations. When provisioning for a UAM, the designer should ensure proper clearance from the chassis bezel and peripheral bays. The system designer should also take into consideration the routing path for the antenna coaxial cable to the PCI Express* WLAN card.

Implementations shown in Figure 5 are for reference and are shown as examples only.

The following figures are UAM placement examples for some common chassis types. The first two figures represent µBTX chassis while the next four figures represent generic tower chassis. Examples shown here are from 13L to 26L. Different colors and patterns are used to identify different mounting zones based UAM RF performance. The green zones are the ideal zones to mount a UAM and comply with regulatory requirements and all performance guidelines. The yellow zones are secondary mounting zones used only if a green zone is unavailable. While the yellow zone locations comply with requirements, they are annotated with letters to describe which performance guideline isn’t fully met. The unmarked zones are not recommended for UAM mounting as these zones are substantially non-compliant with requirements or guidelines.

First Choice Second Choice

26 L chassis examples:

Figure 7. UAM Placement Recommendation Example 1 – Front

Figure 8. UAM Placement Recommendation Example 1 – Rear

Region B in Figure 8 is secondary region because of guideline 3. This region should only be used when no better options are available.

Figure 9. UAM Placement Recommendation Example 2 – Front

Figure 10. UAM Placement Recommendation Example 2 - Rear

Region B in Figure 9 is less than ideal because of its proximity to potential obstructions and edges (guideline 1).

Figure 11. UAM Placement Recommendation Example 3 - Front

Figure 12. UAM Placement Recommendation Example 3 - Rear

In Figure 11, region B is secondary since it is close to vent holes (guideline 2) and doesn't allow for vertical mounting (guideline 3) unless the UAM is placed too close to the FPIO protrusion (guideline 1). In Figure 12, region B2 is a secondary option since its area is small and may not accommodate both UAM orientations according to guideline 3.

4.2.5 Cable Routing Path

Adequate clearance must be provided for the plastic module attachment feature as well as for the coaxial cable. A clear cable routing path should be provided to allow direct routing to the WLAN card free of sharp metal that might cause chaffing of the coaxial cable.

The length of UAM cables will be 61 cm (24"). The distance between the mounting feature and the WLAN PCIe* or mini-card antenna port (i.e. the furthest card location) must be well within 24" or the system integrator will be unable to integrate the UAM into the chassis.

4.2.6 Chassis Markings (optional)

Optional markings may be incorporated into the chassis design to designate this feature as an attachment point for a WLAN antenna module.

4.2.7 Sample Submission

A sample chassis is required for validation by Intel to ensure compliance with this specification.

4.3 For System Integrators

This section describes requirements and design guidelines from the perspective of the system integrator.

4.3.1 Cable Routing Path

A clear cable routing path should be provided to allow direct routing to the WLAN card free of sharp metal that might cause chaffing of the coaxial cable. In addition, it is recommended that cables are routed away from the clock chip, PCIe, and MCH and ICH heat sinks.

4.3.2 Cable Management and Retention

The length of UAM cable will be 61 cm (24”), the system integrator should provision for cable management to prevent damage or disconnection of the cable and connector. It may be desirable for the antenna cable to be secured in place using cable ties or other restraint mechanisms to prevent unseating of the connectors.

It is the system integrator’s responsibility to properly integrate the UAM into the system. Refer to the *Desktop Antenna Integration Guide for 2005* for more details on how to integrate wireless into a desktop PC.

5 Universal Antenna Module Design Example

The following section shows example of a UAM design.

5.1 UAM Design Example

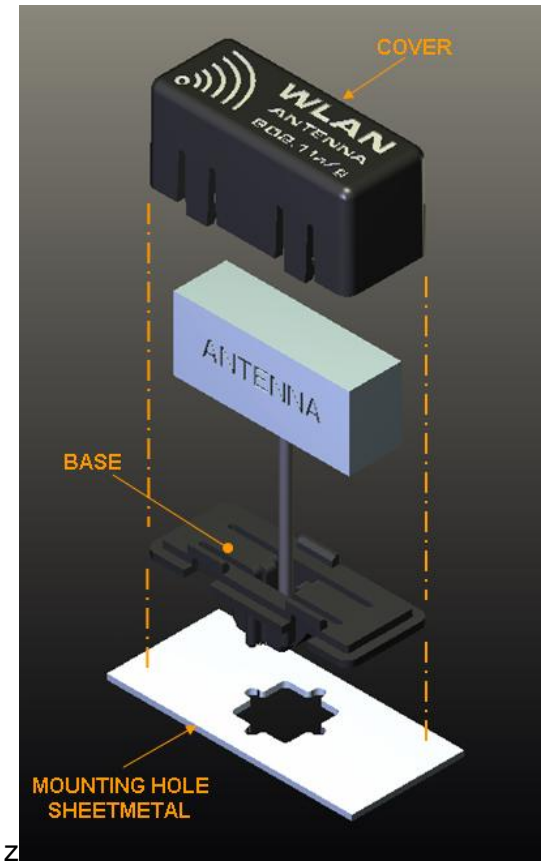

Figure 13. Exploded view of UAM Reference Design

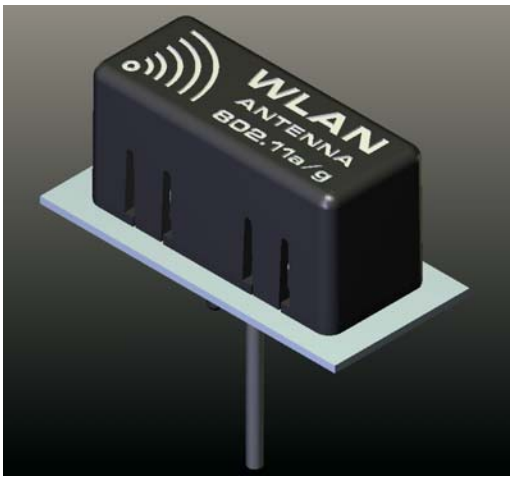

Figure 14. UAM Mounted View

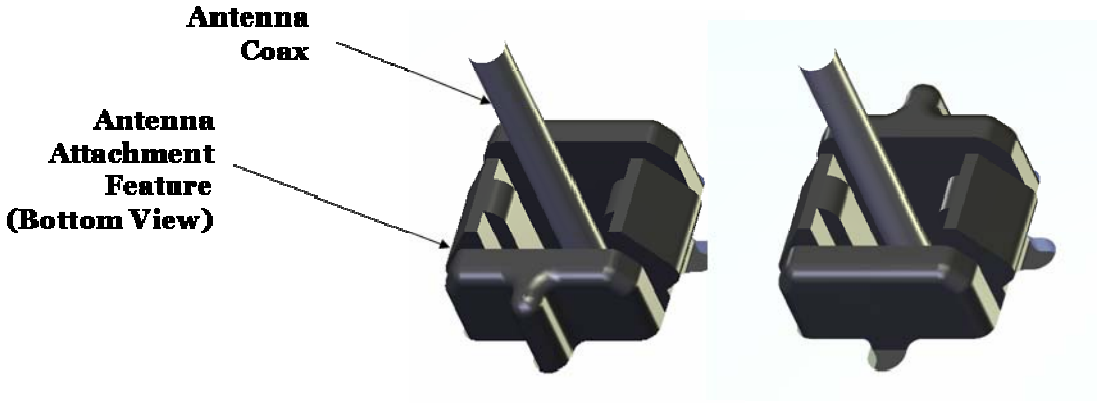

Figure 15. UAM Latching Mechanism Reference Design

CAD data for UAM reference design can be furnished upon request.

Figure 16 shows an example of a wireless-ready system design.

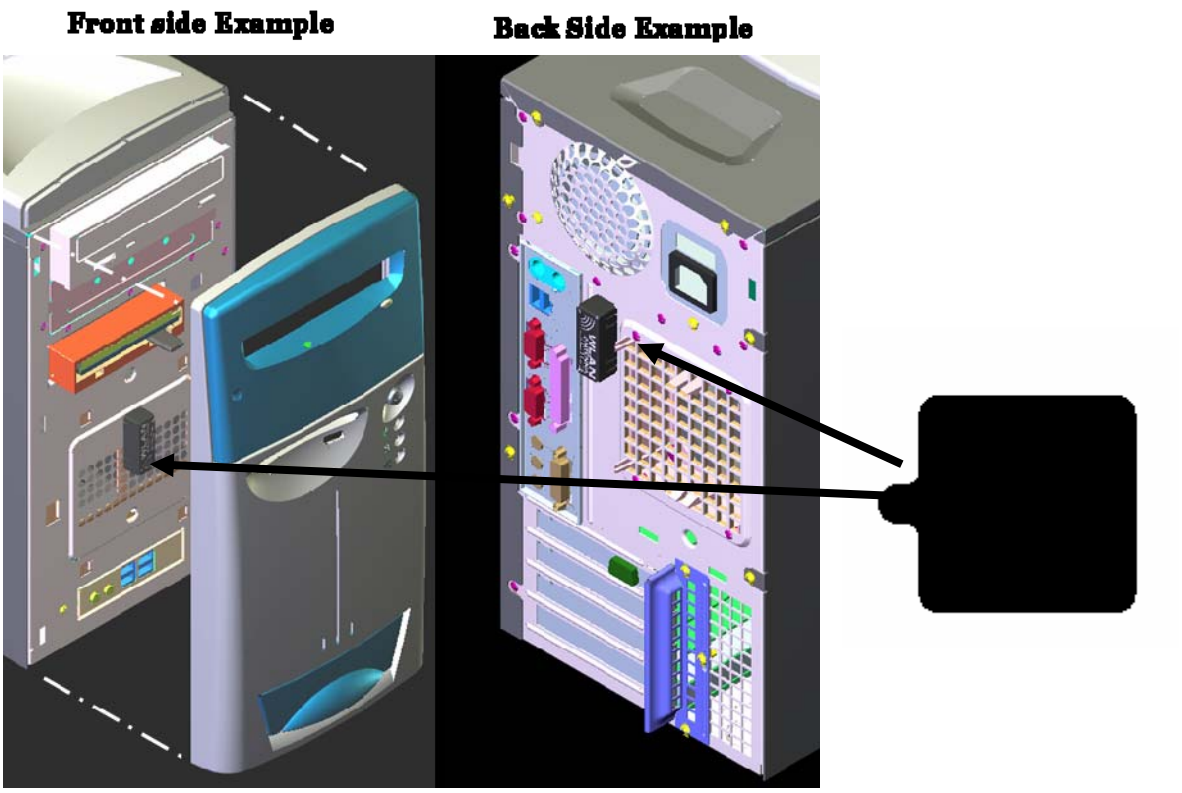

Figure 16. Wireless-ready System Design Example

6 Environmental Design Requirements

The Universal Antenna Module should be designed such that it meets the following environmental design requirements.

Table 2. Environmental Testing Requirements

Characteristic	Specification
Flammability Rating	UL-94 VW-1
Insulation Resistance	5000 ohms @ 300 VDC
Temperature Range	- 55 °C to + 80 °C
Withstand Voltage	1000 VDC @ 60 Hz
Workmanship	Parts shall be uniform in workmanship and appearance. There shall be no excessive nicks, deep scratches, excessive burrs, or defects in materials that may affect the function, serviceability, or appearance of this part. Contact retention equal to or greater than 2.0 oz. per contact, when unmated force: from the proper connector.
Maximum Insertion Force	10 pounds per antenna
Dimensioning and Tolerances	Per ANSI Y14.5M unless otherwise noted on drawing.
UL Marking	The cable manufacturer should supply UL recognized cables that are certified under the UL wiring harness program (ZPFW2). The UL recognition mark should be supplied with the smallest container or bundle of cables with each shipment.
Recognition Mark	The UL recognized wire's insulation will have surface printing identifying the style, flammability rating, manufacturer's name, voltage and temperature ratings, along with the UL mark.
Mechanical Shock	Shall comply with shock testing requirements. Shock testing entails dropping a chassis with an installed antenna twice on all six sides with a g-value of 25g. Change in velocity (in/sec) is dependent upon system weight and ranges between 125 in/sec and 250 in/sec. In order to successfully pass, there should be no evident damage, cracks, or breaks in antenna assembly, no displacement of the antenna from the chassis or displacement of its internal components, and the antenna must operate properly following testing.
Mechanical Vibration	Shall comply with vibration testing requirements. Vibration testing entails an optional sine sweep (.5g peak sine sweep, 5-500Hz, .5 octaves/min) and a random vibration stress both conducted in all 3 axes. In order to successfully pass, there should be no evident damage, cracks, or breaks in antenna assembly, no displacement of the antenna from the chassis or displacement of its internal components, no more than 50% chaffing of cable insulation at metal edge, and the antenna must operate properly following testing.
Restrictions on Hazardous Substances (RoHS)	The antenna assembly including the element, cable and connector must be comply with Restrictions on Hazardous Substances (RoHS) requirements which includes lead free requirements.

Appendix A

This section shows dimensioned drawings for Hirose* U.FL or equivalent connectors and MMCX or equivalent connectors.

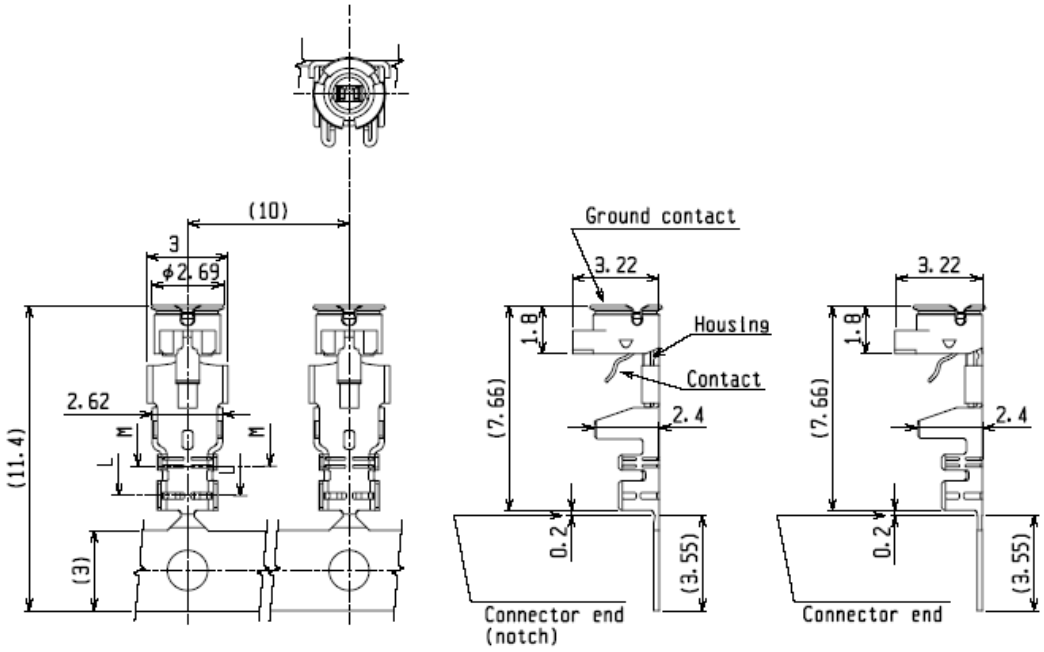

Figure 17. U.FL Connector Example

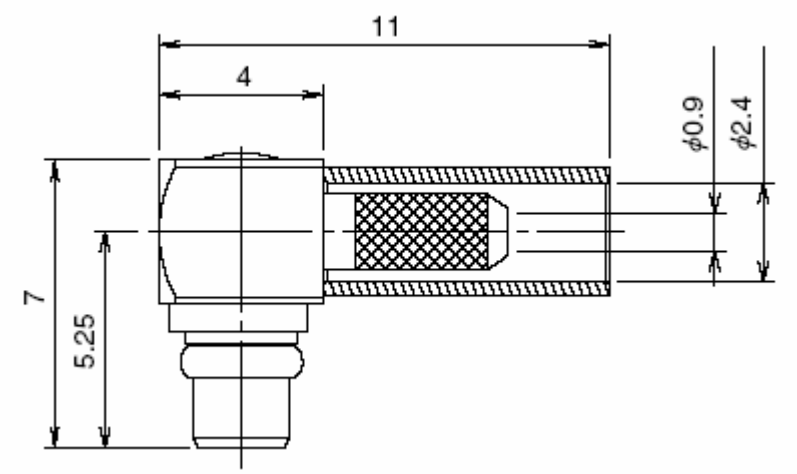

Figure 18. MMCX Connector Drawing Example