Applications:
- Access Points
- Automotive
- Automatic Meter Reading
- Healthcare
- Industrial Devices
- Media Players
- Navigation Equipment
- Notebook PCs – Tablet PCs
- PC/mini-PCI Cards – PDAs
- Point of Sale
- Printers
- Tracking
- WiFi enabled Televisions & Monitors
Table of Contents

1 PURPOSE 4

2 OVERVIEW 4
   2.A The Prestta WLAN Product Line 4
   2.B Product Selection Guide 4
   2.C IMD Technology Advantages 5
   2.D Antenna Features and Benefits Summary 6

3 DESIGN GUIDELINES 7
   3.A Introduction 7
   3.B Electrical Specifications 7
   3.C Mechanical Specifications 7
   3.D Mechanical Dimensions 7
   3.E Measured Data (Baseline VSWR/Efficiency/Peak Gain) 8
   3.F Measured Data (Baseline Radiation Patterns) 9
   3.G Antenna Placement Guidelines 10
   3.H Antenna Tuning Guidelines (Introduction) 11
   3.I Antenna Tuning Guidelines (Antenna Tuning Procedure) 12
   3.K Antenna Tuning Guidelines (2.4GHz: Tune resonance “Higher”) 14
   3.L Antenna Tuning Guidelines (5GHz: Tune resonance “Lower”) 15
   3.M Antenna Placement Data (Real Implementation) 16

4 MATERIAL SPECIFICATIONS 17

5 MANUFACTURING AND ASSEMBLY GUIDELINES 18
   5.A Product Testing 18
1. Purpose

This document provides information for incorporating Ethertronics’ Prestta™ standard embedded antennas into wireless products. Specifications, design recommendations, board layout, packaging and manufacturing recommendations are included.

2. Overview

A. The Prestta WLAN Product Line

The Prestta series of standard WLAN, BT, Zigbee embedded antennas represents a new category of standard, internal antennas. Some Prestta antennas, developed for the same application, come in more than one form factor. The antenna element can be purchased separately from the assembly for increased flexibility. Ethertronics’ antennas utilize proprietary and patented Isolated Magnetic Dipole (IMD) technology to meet the needs of device designers for higher functionality and performance in smaller/thinner designs.

B. Product Selection Guide

<table>
<thead>
<tr>
<th>Antenna PN</th>
<th>Connector</th>
<th>Cable</th>
<th>Adhesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001932FT-AA10L0100</td>
<td>u.FL compatible</td>
<td>Diameter: 1.13 mm</td>
<td>3M468</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Length: 100 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Color: Black</td>
<td></td>
</tr>
<tr>
<td>1001932FT-AA10L0060U</td>
<td>u.FL compatible</td>
<td>Diameter: 1.13 mm</td>
<td>3M468</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Length: 60 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Color: Black</td>
<td></td>
</tr>
</tbody>
</table>

Additional antennas are under development, please see Ethertronics’ Website, or ask your Ethertronics sales person about additional products to meet your needs.
C. IMD Technology Advantages

Real-World Performance and Implementation
Other antennas may contain simple PIFA or monopole designs that interact with their surroundings, complicating layout or changing performance with user position. Ethertronics’ antennas utilize patented IMD technology to deliver a unique size and performance combination.

Stays in Tune
IMD technology provides superior RF field containment, so antennas resist de-tuning to provide a robust radio link regardless of the usage position. Other antennas may experience substantial frequency shifts, and lowered performance, when held by users or placed next to the head.

Smallest Effective Size
Unlike antennas using other technologies, IMD antennas require minimal ground clearance and keep-out areas for surrounding components. This can lead to a smaller “effective” size when all factors are taken into account. In addition to a small "x,y" footprint, Prestta antennas have very low component height to enable ultra-thin, end-user device designs.

IMD Technology: How it works
IMD technology uses confinement of the electrical field to create the antenna’s mode. The strongly confined antenna mode reduces its coupling to the surrounding environment. The diagram to the right shows the electrical field created on the PCB ground plane for an Ethertronics IMD antenna and a PIFA (Planar Inverted F Antenna). Red areas indicate the highest current while blue areas signify the lowest. As demonstrated, currents from the IMD design are highly localized, while high currents are observed all the way over to the ground plane edge on the PIFA.

Ethertronics’ IMD antennas are ideally suited for wireless data devices, where performance, size and system costs are critical. The surface mount design and compact size are suited for high volume applications. Standard antenna profiles are available or can be configured to suit individual OEM requirements.
D. Antenna Features and Benefits Summary (Prestta Standard 1001932FT Antenna)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Advantage</th>
</tr>
</thead>
</table>
| Tunable Embedded FPC Antenna with standard 100mm cable. | • Minimize antenna design cycle with tunable antenna  
• Flexibility in antenna placement and cabling used  
• Ability to source cabling from ET or through other means  
• Ability to source antenna only for direct placement in customer’s product. |
| Embedded solutions for WLAN/BT/Zigbee | • Eliminates external antennas  
• More desirable form factors  
• Uses in access points, routers, gateways, wireless displays/TVs, and other consumer electronic devices |
| High Performance | • Better performance than external dipole in diversity antenna situation |
| Extensive design collateral and apps support | • Speed of development time |
| Standard “Off the Shelf” Product | • Speeds development time and reduces costs since reduces NRE and custom development time |
3. Design Guidelines

A. Introduction
The Prestta standard WLAN embedded antennas can be designed into many wireless product types. The following sections explain Ethertronics’ performances/recommendations to help the designer integrate the 1001932FT antenna on a plastic assembly or into a device for optimum performance.

B. Electrical Specifications
Typical Characteristic Measurements taken with a 100 mm cables tested on PC-ABS.

<table>
<thead>
<tr>
<th>Antenna</th>
<th>2.400 - 2.485 GHz</th>
<th>5.150 - 5.825 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Gain</td>
<td>2.5dBi</td>
<td>4.4dBi</td>
</tr>
<tr>
<td>Average Efficiency</td>
<td>60%</td>
<td>71%</td>
</tr>
<tr>
<td>VSWR Match</td>
<td>2.0:1 max</td>
<td></td>
</tr>
<tr>
<td>Feed Point Impedance</td>
<td>50 ohms unbalanced</td>
<td></td>
</tr>
<tr>
<td>Power Handling</td>
<td>0.5-Watt CW</td>
<td></td>
</tr>
<tr>
<td>Polarization</td>
<td>Linear</td>
<td></td>
</tr>
</tbody>
</table>

C. Mechanical Specifications

<table>
<thead>
<tr>
<th>Maximum Dimensions</th>
<th>35.2 x 8.5 x 1.6 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Mounting</td>
<td>Antenna Assembly is cable + FPC</td>
</tr>
<tr>
<td>RF Mounting</td>
<td>Adhesive on bottom side of antenna then apply to Plastic wall</td>
</tr>
</tbody>
</table>

D. Mechanical Dimensions
Typical 1001932FT Mechanical Dimensions with a 100 mm cable.

Product specifications subject to change without notice.
E. Measured Data (Baseline)

VSWR, Efficiency and Peak Gain

Typical Characteristic Measurements taken with a 100 mm cables tested on PC-ABS.

2.4 GHz VSWR

5 GHz VSWR

2.4 GHz Efficiency

5 GHz Efficiency

2.4 GHz Peak Gain

5 GHz Peak Gain

Product specifications subject to change without notice.
F. Measured Data (Baseline)

*Radiation Patterns*

Typical Characteristic Measurements taken with a 100 mm cables tested on PC-ABS.

Product specifications subject to change without notice.
G. Antenna Placement Guidelines-1001932FT

In order to create an optimized layout for the 1001932FT antenna, the following guidelines should be followed.

- The antenna should be placed on plastic wall as far as possible from other objects so that it can radiate as if in free space.
- 90° from PCB or any ground plane is preferred antenna placement, see Figure 1 below.

- Populated components within device may not have direct contact with antenna (battery, cables...etc.)
- Antenna is not accustomed to be mounted to glass.
- Antenna cable must not be pinched or pulled and handled with care. Figure 2 and 3 show minimum straight length of cable before radius with different cable diameters.

<table>
<thead>
<tr>
<th>CABLE DIAMETER</th>
<th>MINIMUM BEND RADIUS (mm)</th>
<th>MINIMUM STRAIGHT LENGTH BEFORE BEND (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.82mm</td>
<td>4.2mm</td>
<td>1.8mm</td>
</tr>
<tr>
<td>*1.13mm</td>
<td>6.0mm</td>
<td>2.0mm</td>
</tr>
<tr>
<td>1.37mm</td>
<td>10.0mm</td>
<td>4.1mm</td>
</tr>
</tbody>
</table>

* Diameter 1.13mm cable used for standard 1001932 antenna

- Implementing 2 or more antennas within a device requires orthogonal orientation placement with respect to each antenna is preferred to reduce coupling and improve antenna isolation, see Figure 4 below.

For metal objects
- The antenna should always be kept as far away from other metal objects as possible. (Display, frames, cables, connectors LED...etc.
- No direct contact to metal (above and under)
- It is not recommended to place antenna directly on PCB.

For dielectric objects
- Recommended placement of antenna is on PC or PC-ABS plastic material.
- Recommended to place antenna on side wall away from PCB, see Figure 5 below
- Do not center antenna between PCB, see Figure 6 below

Figure: 1

Figure: 2

Figure: 3

Figure: 4

Figure: 5

Figure: 6

Product specifications subject to change without notice.
H. Antenna Tuning Guidelines Introduction- 1001932FT

The 1001932FT is a Tunable FPC antenna with RF cable and connector. The 1001932FT Tunable FPC antenna can be mounted onto any housing for versatile positioning. For the purposes of the Design Guidelines section, the 1001932FT has been mounted on a device housing made of PC/ABS plastic with a 100 mm long cable.

*This antenna has unique features enabling limited range RF tuning by leaving variations of P1 - P6 connected by “solder bridge” or C1 - C2 disconnected with a “cut” to the trace. Refer to detailed tuning options below.

Ref: Baseline = Typical Performance using 100 mm cable tested on PC-ABS

**Options for Tuning: “2.4GHz (Lower)”**

<table>
<thead>
<tr>
<th>MODE</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADS</td>
<td>Connect: P2</td>
<td>Connect: P1</td>
<td>Connect: P2+P3</td>
<td>Connect: P1+P3</td>
</tr>
<tr>
<td>Outcome:</td>
<td>~200 MHz</td>
<td>~250 MHz</td>
<td>~350 MHz</td>
<td>~370 MHz</td>
</tr>
<tr>
<td>(Ref: Baseline)</td>
<td>shift low</td>
<td>shift low</td>
<td>shift low</td>
<td>shift low</td>
</tr>
</tbody>
</table>

**Options for Tuning: “2.4GHz (Higher)”**

<table>
<thead>
<tr>
<th>MODE</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADS</td>
<td>Cut: C1</td>
<td>Cut: C2</td>
</tr>
<tr>
<td>Outcome:</td>
<td>~170 MHz</td>
<td>~300 MHz</td>
</tr>
<tr>
<td>(Ref: Baseline)</td>
<td>shift high</td>
<td>shift high</td>
</tr>
</tbody>
</table>

**Options for Tuning: “5GHz (Lower)”**

<table>
<thead>
<tr>
<th>MODE</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADS</td>
<td>Connect: P4</td>
<td>Connect: P4+P5</td>
<td>Connect: P6</td>
<td>Connect: P5+P6</td>
</tr>
<tr>
<td>Outcome:</td>
<td>~200 MHz</td>
<td>~1500 MHz</td>
<td>~500 MHz</td>
<td>~1900 MHz</td>
</tr>
<tr>
<td>(Ref: Baseline)</td>
<td>shift low</td>
<td>shift low</td>
<td>shift low</td>
<td>shift low</td>
</tr>
</tbody>
</table>

Product specifications subject to change without notice.
I. Antenna Tuning Guidelines (Tuning Procedure)

This antenna has unique features enabling limited range RF tuning by solder bridging or cutting specified area. Ease of on the fly tuning for any application with a soldering iron and knife. Tuning optional if required.

Antenna Tuning (Lower)

*Add bridge of solder to connect pads for tuning

Filled Gap

Antenna Tuning (Higher)

*Scratch solder mask to expose copper layer

*Cut trace through copper layer

Cut Gap

Product specifications subject to change without notice.
J. Antenna Tuning Guidelines

In real application environments, variation of the antenna resonate frequency may be caused by the following effects:

- Different antenna locations
- Plastic variation
- Components and shield cans located close to the antenna
- Outside Cover

The following methods can be applied to solve the above effects:

- bg band: Pattern Tuning by solder bridge to shift resonance lower or cut pattern to tune higher.
- a band: Pattern Tuning by solder bridge to shift resonance lower

Antenna Tuning – 2.4GHz: Tune resonance “Lower”:

The following tuning methods focus on tuning 2.4GHz resonance after placing antenna in device:

- Place antenna on designated antenna position. Did 2.4GHz resonance shift HIGH?
- If “Yes”, select corresponding Modes (T1-T4) to accommodate shift. Add solder bridge to generate shift.
- See Figure 7

MODES:

<table>
<thead>
<tr>
<th>MODE</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADS</td>
<td>Connect: P2</td>
<td>Connect: P1</td>
<td>Connect: P2+P3</td>
<td>Connect: P1+P3</td>
</tr>
<tr>
<td>Outcome: (Ref: Baseline)</td>
<td>~200 MHz shift low</td>
<td>~250 MHz shift low</td>
<td>~350 MHz shift low</td>
<td>~370 MHz shift low</td>
</tr>
</tbody>
</table>

Figure: 7

Product specifications subject to change without notice.
K. Antenna Tuning Guidelines
Antenna Tuning – 2.4GHz: Tune resonance “Higher”:

The following tuning methods focus on tuning 2.4GHz resonance after placing antenna in device.
- Place antenna on designated antenna position. Did 2.4GHz resonance shift LOW?
- If “Yes”, select corresponding Modes to accommodate shift. Use razor blade to cut pattern to preferred shift (C1, C2).
- See Figure 8

MODES:

<table>
<thead>
<tr>
<th>MODE</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADS</td>
<td>Cut: C1</td>
<td>Cut: C2</td>
</tr>
<tr>
<td>Outcome: (Ref: Baseline)</td>
<td>~170 MHz shift high</td>
<td>~300 MHz shift high</td>
</tr>
</tbody>
</table>

[Diagram showing tuning methods with labels C1 and C2]

\[\text{Figure: 8}\]

Product specifications subject to change without notice.
L. Antenna Tuning Guidelines

Antenna Tuning– 5GHz: Tune resonance "LOWER":

The following tuning methods focus on tuning 5GHz resonance after placing antenna in device.

- Place antenna on designated antenna position. Did 5GHz resonance shift HIGH?
- If “Yes”, select corresponding Modes (T5-T8) to accommodate shift. Add solder bridge to generate shift.
- See Figure 9

<table>
<thead>
<tr>
<th>MODE</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADS</td>
<td>Connect: P4</td>
<td>Connect: P4+P5</td>
<td>Connect: P6</td>
<td>Connect: P5+P6</td>
</tr>
<tr>
<td>Outcome: (Ref: Baseline)</td>
<td>~200 MHz shift low</td>
<td>~1500 MHz shift low</td>
<td>~500 MHz shift low</td>
<td>~1900 MHz shift low</td>
</tr>
</tbody>
</table>

![Figure 9](image)

Product specifications subject to change without notice.
M. Antenna Placement Data (Real Implementation)-1001932FT

Real life implementation of 1001932FT antenna of actual and thought process to tune antenna to a given environment.

Step 1:
Identify optimal antenna location based on “3.G Antenna Placement Guidelines—1001932FT”

*Key Notes: Place antenna on inner plastic wall away from metal and other board components. Stay away from metal as much as possible.

Step 2:
Test baseline return loss for 100932FT (unmodified on inner wall) to determine shifts of antenna resonances.

- The antenna should always be kept as far away from other metal objects as possible.
- We will look at 2.4GHz first and it’s return loss.
- Baseline 1001932FT 2.4GHz resonance has shifted high.
- Identified shift to be closest to “MODE T1” by referencing to:
  “3.H Antenna Tuning Guidelines (Introduction)”
- Implement “MODE T1” by following “Antenna Tuning–2.4GHz: Tune resonance “Lower” instructions by adding solder bridge on P2. Verify antenna is tuned for designated bands.
- 2.4Ghz is tuned in Band, Look at 5GHz in the following slide.

Product specifications subject to change without notice.
Step 3:
Test 100932FT baseline (unmodified on inner wall) to determine shifts of antenna resonances.

- We will know look at 5GHz return loss and tune as necessary.
- Baseline shows 1001932FT 5GHz resonance has shifted high.
- Identified shift to be closest to “MODE T5” by referencing to: “3.H Antenna Tuning Guidelines (Introduction)”.
- Implement “MODE T5” by following (Antenna Tuning– 5GHz: Tune resonance “Lower”) instructions by adding solder bridge on P4. Verify antenna is tuned for designated bands.
- 5GHz resonance is tuned in band by adding a solder bridge to P4 pad.

Before Tuning (5GHz)  
![Before Tuning Image](image1)

After Tuning (5GHz)  
![After Tuning Image](image2)

After applying **Mode T5**, 5GHz resonant frequency is tuned in band.

Before and After Tuning (Return Loss) (5GHz)  
![Return Loss Graph](image3)

Before and After Tuning (Efficiency) (5GHz)  
![Efficiency Graph](image4)

Product specifications subject to change without notice.
4. Material Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Element</td>
<td>Copper</td>
</tr>
<tr>
<td>Contact Finish</td>
<td>Ni and selective Au standard</td>
</tr>
<tr>
<td>Plastic Carrier</td>
<td>Composite (LCP or similar)</td>
</tr>
<tr>
<td>FPC</td>
<td>PI</td>
</tr>
<tr>
<td>Cable</td>
<td>Micro Coaxial (where applicable)</td>
</tr>
<tr>
<td>Connector</td>
<td>U.FL Receptacle (where applicable)</td>
</tr>
</tbody>
</table>

5. Product Testing

<table>
<thead>
<tr>
<th>NO</th>
<th>Test Type</th>
<th>Items</th>
<th>Test condition</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High Temp.</td>
<td>85°C±3°C</td>
<td>120hr ±2hr</td>
<td>Step 1: Test VSWR (by jig for antenna only elements/no PCB). Step 2: Put it in the chamber. Step 3: Test it like this picture which explains temp. cycle. Step 4: Test VSWR after 1hr in normal Temp. &amp; normal Humidity</td>
</tr>
<tr>
<td>2</td>
<td>Low Temp.</td>
<td>-40°C±3°C</td>
<td>120hr ±2hr</td>
<td>Step 1: Test VSWR (by jig for antenna only elements/no PCB). Step 2: Put it in the chamber. Step 3: Test it like this picture which explains temp. cycle. Step 4: Test VSWR after 1hr in normal Temp. &amp; normal Humidity</td>
</tr>
<tr>
<td>3</td>
<td>High Temp. &amp; High Humidity</td>
<td>85°C±3°C</td>
<td>RH=85% 120hr ±2hr</td>
<td>Step 1: Test VSWR (by jig for antenna only elements/no PCB). Step 2: Put it in the chamber. Step 3: Test it like this picture which explains temp. cycle. Step 4: Test VSWR after 1hr in normal Temp. &amp; normal Humidity</td>
</tr>
<tr>
<td>4</td>
<td>Salt Spray</td>
<td>NaCl 5%, 35°C, 7hr</td>
<td></td>
<td>Step 1: Test VSWR (by jig for antenna only elements/no PCB). Step 2: Put it in the chamber. Step 3: Start test. Step 4: Wash the samples. Step 5: Test VSWR after 1hr in normal Temp. &amp; normal Humidity</td>
</tr>
<tr>
<td>5</td>
<td>Thermal shock</td>
<td>-40°C±3°C/30min, 85°C±3°C/30min, 32cycle</td>
<td></td>
<td>Step 1: Test VSWR (by jig for antenna only elements/no PCB). Step 2: Put it in the chamber. Step 3: Test it like this picture which explains temp. cycle. Step 4: Test VSWR after 1hr in normal Temp. &amp; normal Humidity</td>
</tr>
</tbody>
</table>

Product specifications subject to change without notice.