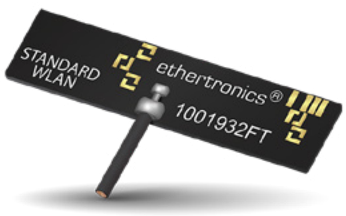
APPLICATION NOTES
AN-PT-WLAN-MP-20192202

Multiuse Worldwide WLAN BT Zigbee Tunable Embedded PCB Cabled Antenna

1001932FT



Access Points
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Printers
Tracking
WiFi enabled Televisions & Monitors

PresttaTM WLAN/BT/Zigbee Tunable Embedded PCB Antenna

Table of Contents

Purpose

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

This document is divided into two parts: a main section and appendices. The main section addresses points and issues common to all products. The appendices provide product-specific information.

Overview

The Prestta LTE 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. In addition some Prestta antennas require ground clearance while others can be placed directly on ground; providing additional flexibility for designers. KYOCERA AVX's 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.

Product Selection Guide

Antenna PN	Connector	Cable	Adhesive
1001932FT-AA10L0100	• u.FL compatible	• Diameter: 1.13mm • Length: 100mm • Color: Black	• 3M468
1001932FT-AA10L0060U	• u.FL compatible	• Diameter: 1.13mm • Length: 60mm • Color: Black	• 3M468

Additional antennas are under development, please see KYOCERA AVX's Website, or ask your KYOCERA AVX sales person about additional products to meet your needs.

Figure 1

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. KYOCERA AVX's 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.

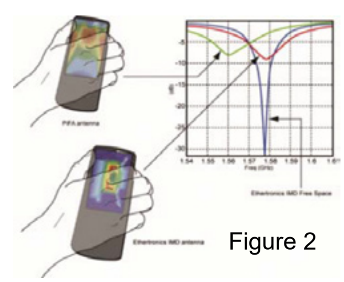
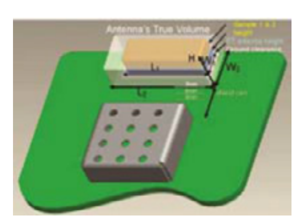


Figure 2

Smallest Effective Size

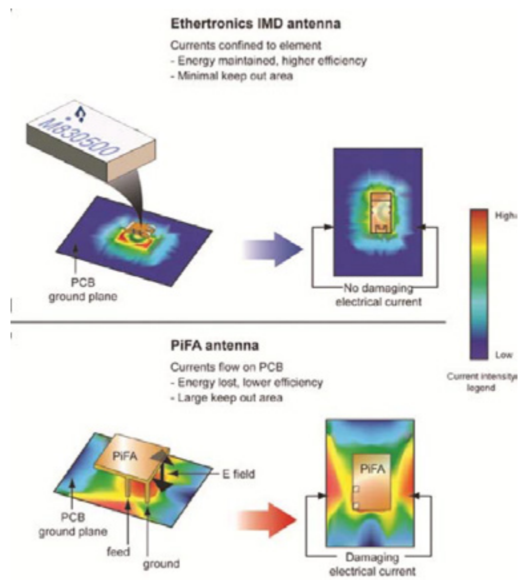
Unlike antennas using other technologies, IMD antennas require minimal ground clearance and keep-out areas for surrounding components. This can lead to a smaller "effective" size when all factors are taken into account. In addition to a small "x,y" footprint, Prestta antennas have very low component 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 KYOCERA AVX 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.

KYOCERA AVX's 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.



Antenna Features and Benefits Summary *(Prestta Standard 1001932PT Antenna)*

Feature	Connector
Tunable Embedded PCB 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 on customer PCB
Embedded solutions for WLAN/BT/Zigbee	• Eliminates external antennas • More desirable form factors • Uses in access points, routers, gateways, wireless display/TVs, and other consumer electronic devices
High Performance	• Better performance than external dipole in diversity antenna situation
Ground Cleared and On Ground solutions	• Enables flexibility in antenna placement within end device • Can be used within Access Points, Routers, Handhelds, Displays
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

Design Guidelines

Introduction

The Prestta standard WLAN embedded antenna can be designed into many wireless product types. The following sections explain KYOCERA AVX's recommended layouts to help the designer integrate the 1001932PT antenna on plastic assembly and 1001932PT antenna element into a device with optimum performance.

Electrical Specifications

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

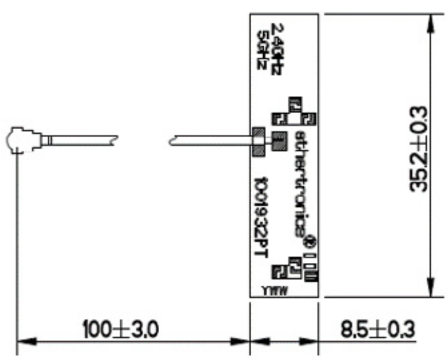
WLAN/BT/Zigbee Antenna	2.400 - 2.485 GHz	5.150 - 5.825 GHz
Peak Gain	2.5dBi	4.4dBi
Average Efficiency	60%	71%
VSWR Match	2.0:1 max	
Feed Point Impedance	50 ohms unbalanced	
Power Handling	0.5-Watt CW	
Polarization	Linear	

Mechanical Specifications

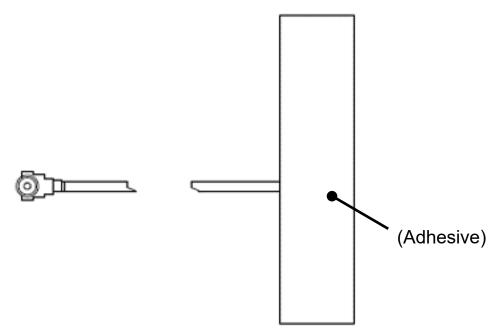
Maximum Dimensions	35.2 x 8.5 x 1.8 mm
Mechanical Mounting	Antenna Assembly is cable + PCB
RF Mounting	Adhesive on bottom side of antenna then apply to Plastic wall

Mechanical Dimensions

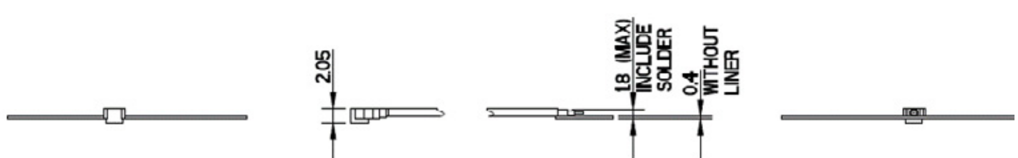
Typical 1001932PT Mechanical Dimensions with 100mm cable



Top View



Bottom View



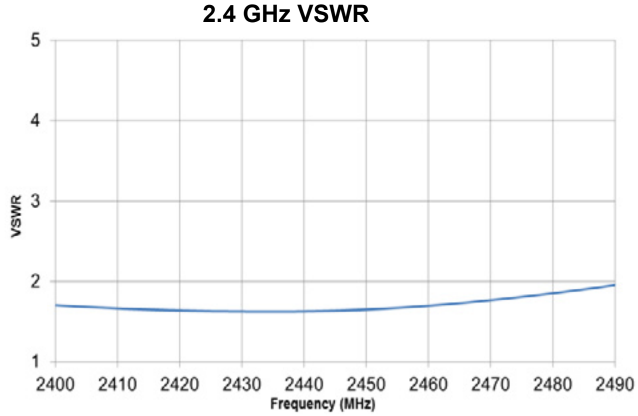
Side View

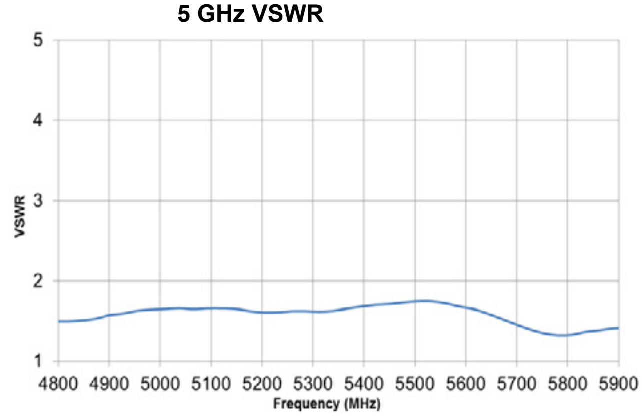
Prestta™ WLAN/BT/Zigbee Tunable Embedded PCB Antenna

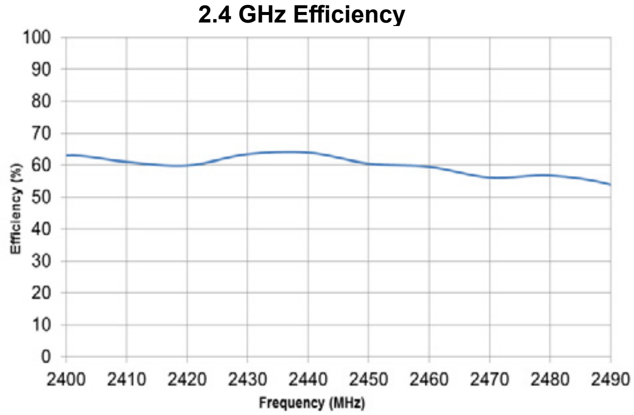
1001932FT

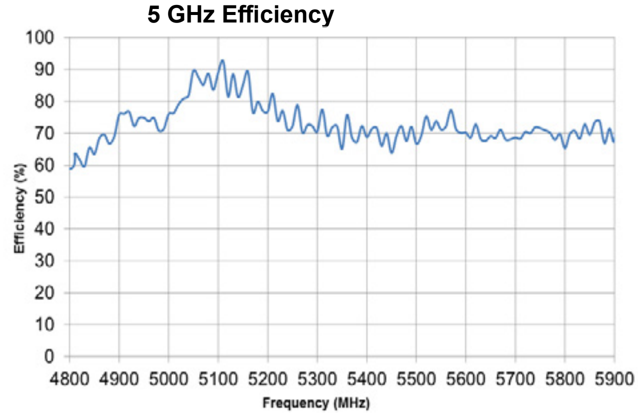
Measured Data (Baseline VSWR and Efficiency)

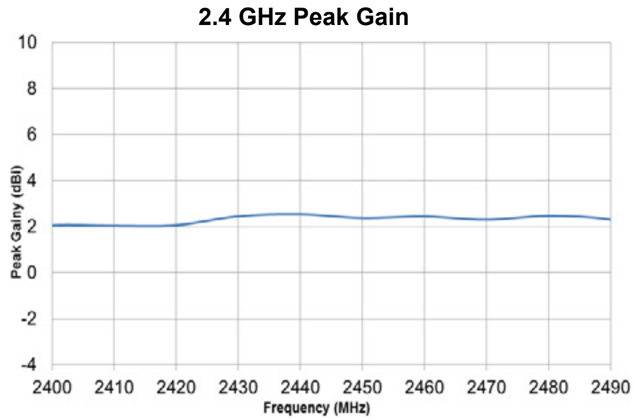
Typical Characteristic Measurements taken with 100 mm cables tested on PC-ABS

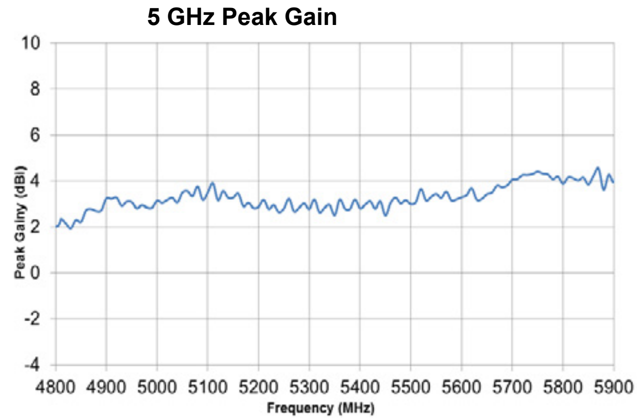






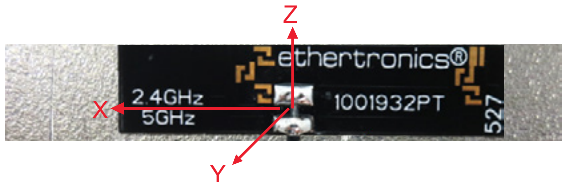




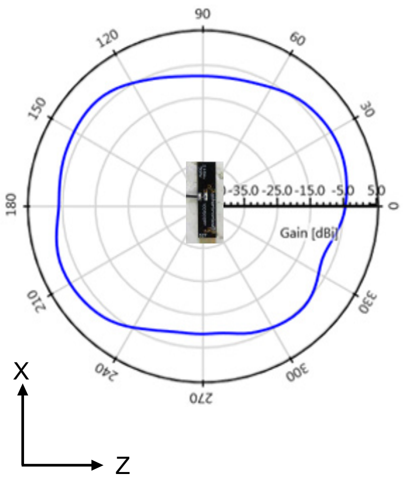


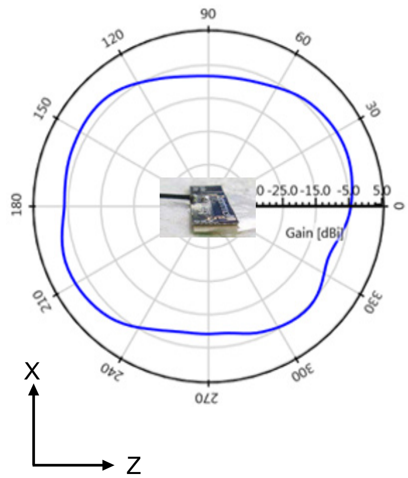
Measured Data (Baseline Radiation Patterns)

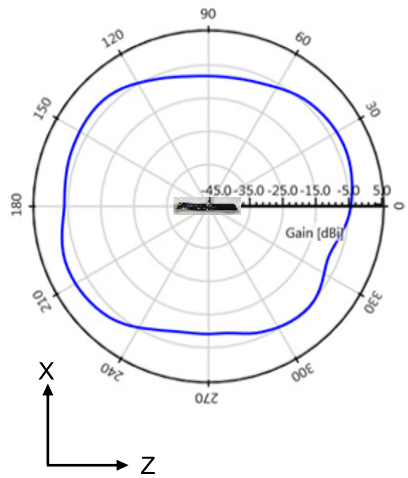
Typical Characteristic Measurements taken with 100 mm cables tested on PC-ABS



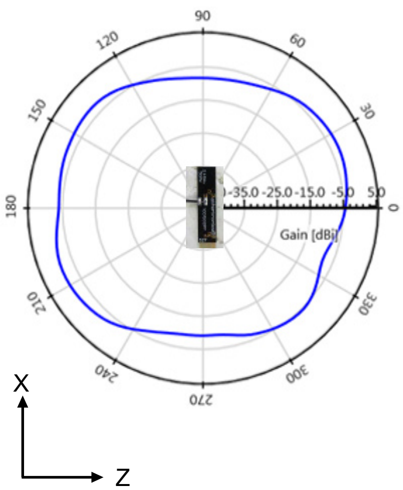
Measured at 2440 MHz

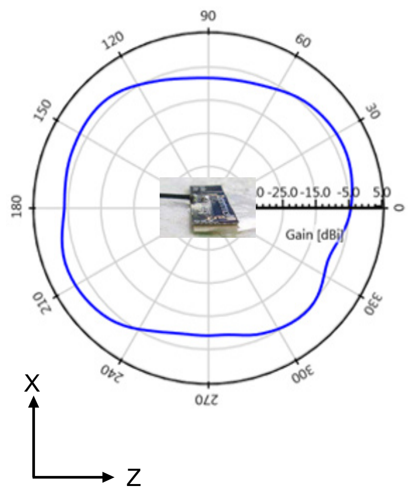


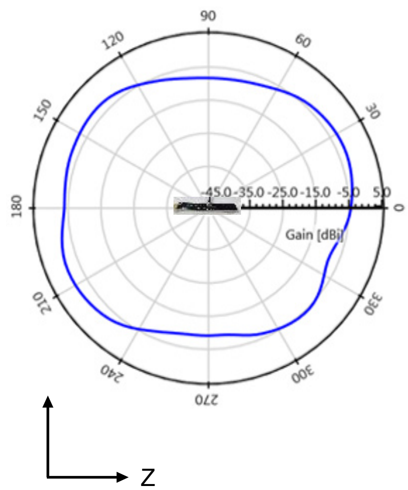




Measured at 5450 MHz







Product specifications subject to change without notice.

Tuning Guidelines Introduction- 1001932PT

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

*This antenna has unique features enabling limited range RF tuning by leaving P1 - P6 and C1 - C2 connected by "solder bridge" or 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)"

MODE	T1	T2	T3	T4
PADS	Connect: P2	Connect: P1	Connect: P2+P3	Connect: P1+P3
Outcome: (Ref: Baseline)	~200 MHz shift low	~250 MHz shift low	~350 MHz shift low	~370 MHz shift low

Options for Tuning: "2.4GHz (Higher)"

MODE	C1	C2
PADS	Cut: C1	Cut: C2
Outcome: (Ref: Baseline)	~170 MHz shift high	~300 MHz shift high

Options for Tuning: "5GHz(Lower)"

MODE	T5	T6	T7	T8
PADS	Connect: P4	Connect: P4+P5	Connect: P6	Connect: P5+P6
Outcome: (Ref: Baseline)	~200 MHz shift low	~1500 MHz shift low	~500 MHz shift low	~1900 MHz shift low

Tuning Guidelines

In real application environment, variation of the antenna resonating frequency may be caused by a the following effects

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

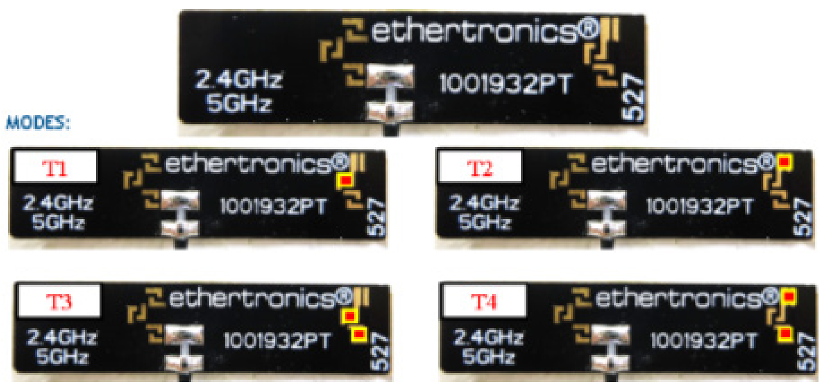
The following methods can be applied to solve the above effects

- bg band: Pattern Tuning by solder bridge to shift lower or cut pattern to tune higher.
- a band: Pattern Tuning by solder bridge to shift 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 9



Connection: Bridge with solder to tune antenna

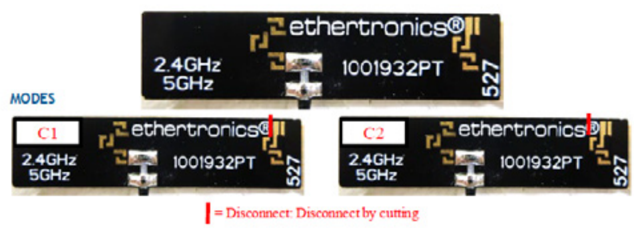
MODE	T1	T2	T3	T4
Outcome: (Ref: Baseline)	~200 MHz shift low	~250 MHz shift low	~350 MHz shift low	~370MHz shift low

Product specifications subject to change without notice.

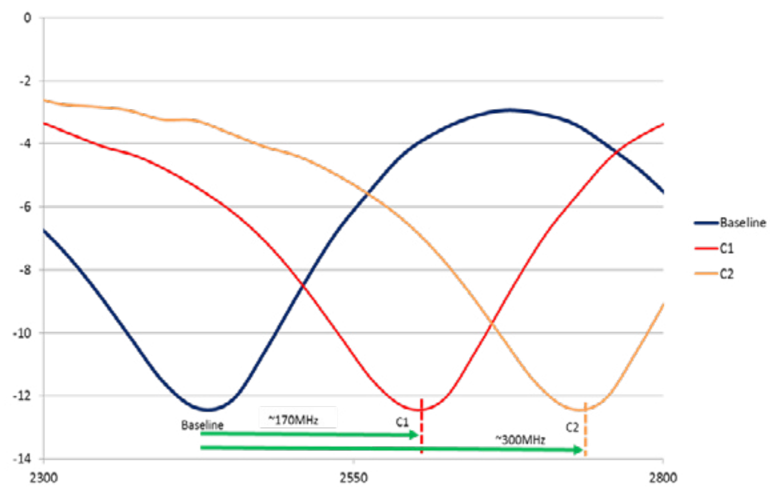
Antenna Tuning–2.4GHz: Tune resonance "Higher":

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 10



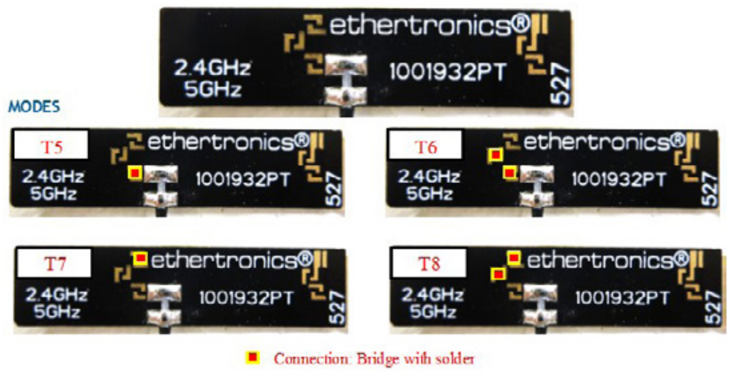
MODE	C1	C2
Outcome: (Ref: Baseline)	~170 MHz shift low	~300 MHz shift low



Antenna Tuning–2.4GHz: Tune resonance "Lower":

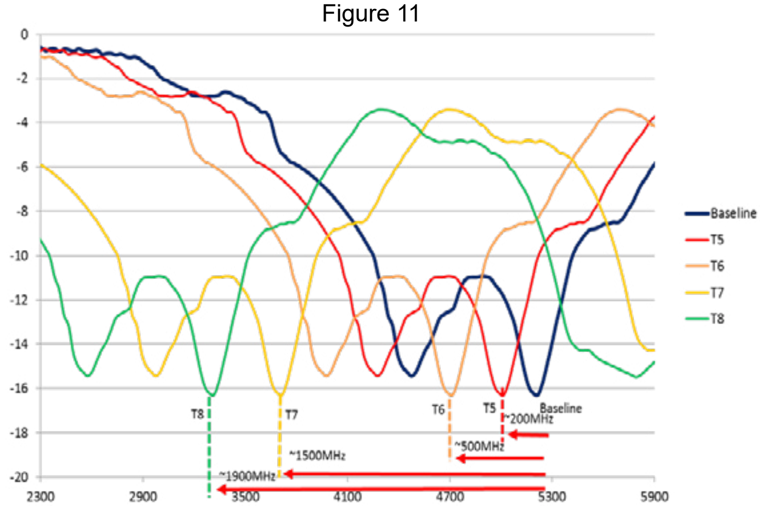
The following tuning methods focus on tuning 5GHz resonance after placing antenna in device.

- 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 11



MODE	T5	T6	T7	T8
Outcome: (Ref: Baseline)	~200 MHz shift low	~1500 MHz shift low	~500 MHz shift low	~1900 MHz shift low

Figure 11



Antenna Placement Guidelines-1001932PT

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

- The antenna should be placed as far as possible from other objects so that it can radiate as if in free space while located load by plastic wall

For metal objects

- The antenna should always be kept as far away from other metal objects as possible.

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 1 below

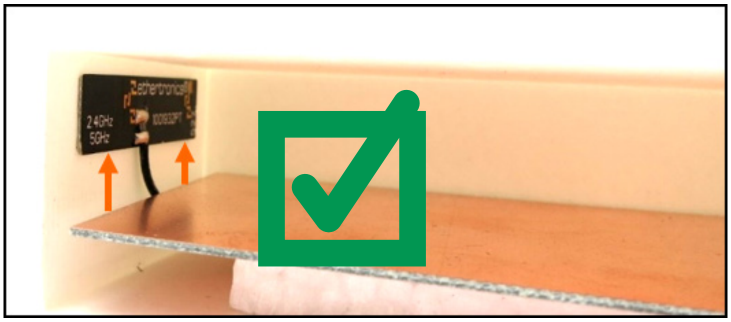


Figure: 1

- Do not center antenna between PCB, see Figure 2 at bottom

Figure: 2

Antenna Placement Data (Real Implementation)-1001932PT

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

Step1:

Identify optimal antenna location based on “3.K Antenna Placement Guidelines—1001932PT”

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

1001932PT was placed above ground plane for maximum performance.

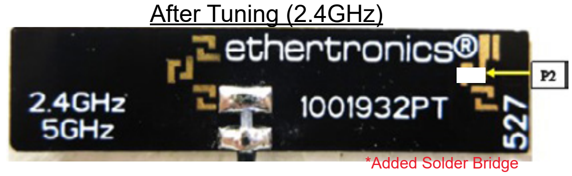
Step2:

Test 100932PT baseline (unmodified on inner wall) to determine shifts of antenna resonances

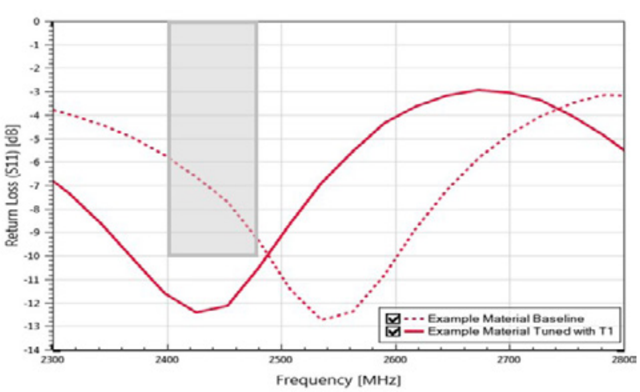
- The antenna should always be kept as far away from other metal objects as possible.
- We will look at 2.4GHz first and it’s return-loss.
- Baseline 1001932PT 2.4GHz resonance has shifted high.
- Identified shift to be closest to “MODE T1” by referencing to: “3.G Antenna Tuning Guidelines (Introduction)”
- 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.

Before Tuning (2.4GHz)

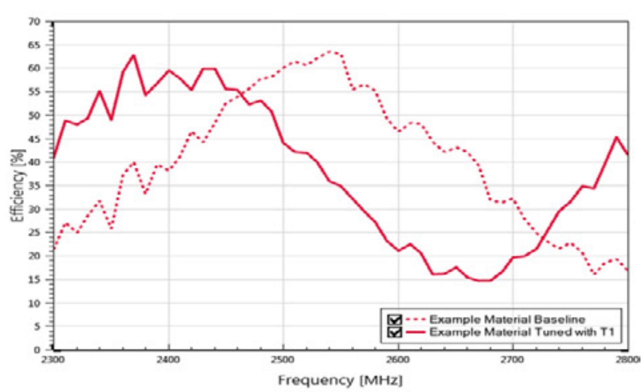
After Tuning (2.4GHz)



Before and After Tuning (Return-Loss) (2.4GHz)



Before and After Tuning (Efficiency) (2.4GHz)



Step3:

Test 100932PT 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 1001932PT 5GHz resonance has shifted high.
- Identified shift to be closest to “MODE T5” by referencing to: “3.G 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.

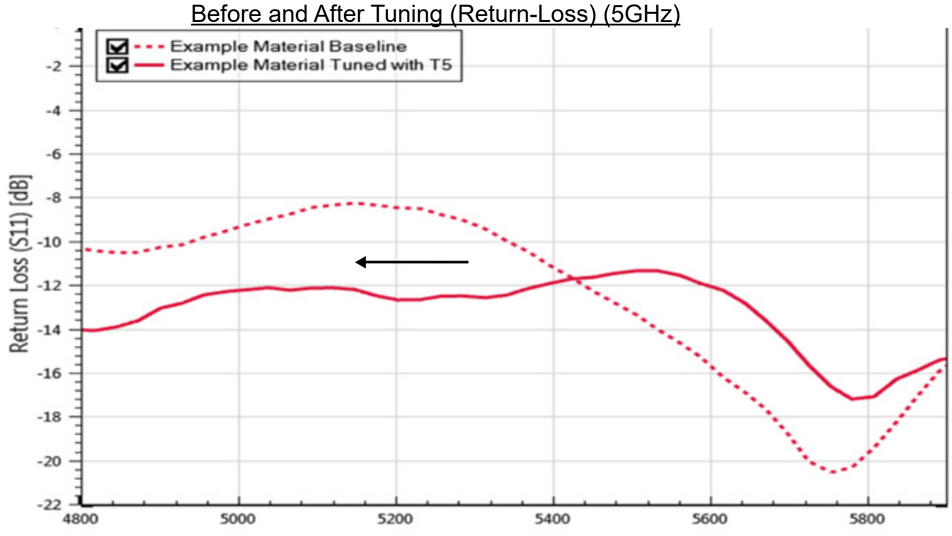
Before Tuning (5GHz)

After Tuning (5GHz)

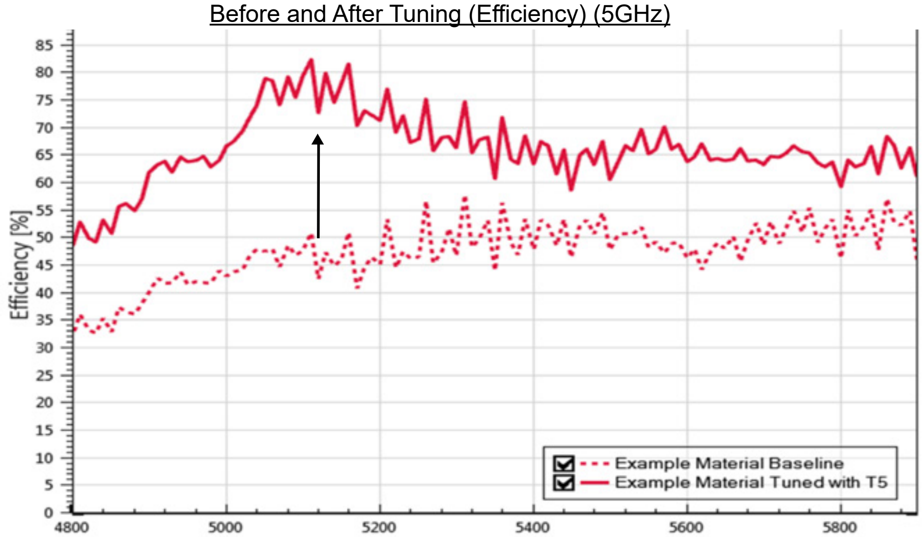
*Added Solder Bridge

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

Before and After Tuning (Return-Loss) (5GHz)



Before and After Tuning (Efficiency) (5GHz)



Material Specifications

Item	Material
Metal Element	Various (C5210, SUS301, SUS304 and others)
Contact Finish	Ni and selective Au standard
Plastic Carrier	Composite (LCP or similar)
PCB	FR4 (where applicable)
Cable	Micro Coaxial (where applicable)
Connector	U.FL Receptacle (where applicable)

Product Testing

NO	Test Type	Items	Test Condition	Test Method
1	Environment Test	High Temp.	85°C±3°C 120hr ± 2hr	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. & normal Humidity
2		Low Temp.	-40°C±3°C 120hr ± 2hr	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. & normal Humidity
3		High Temp. & High Humidty	85°C±3°C RH=85% 120hr ± 2hr	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. & normal Humidity
4		Salt Spray	Nacl 5%, 35°C, 72hr	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: Wash the samples. Step 4: Test VSWR after 1hr in normal Temp. & normal Humidity
5		Thermal Shock	-40°C±3°C/30min 85°C±3°C/30min, 32 cycle	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. & normal Humidity
6	Reflow Test	Reflow Test	Pre Heating 200°C±5°C 30~60sec Peak Heating 260°C±5°C	Step 1: Put it in REFLOW Step 2: Test it like this picture which explains temp. Cycle by EV board
7	Mechanical Test*	Vibration*	- Frequency: 10~500hz - Acceleration: 10*9.8m/§(G) - Sweep time 15min - X.Y.Z each 5 times	Step 1: Solder antenna on EV board. Step 2: Assemble EV board (+antenna) on set. Step 3: Test it
8		Drop*	- From 152cm height, drop the sample to the bottom 18 times per one test by drop jig. (each 3 time on 6 surfaces) - Jig: using the plastic jig (120±20g) - Material of Bottom: Iron Plate	Step 1: Solder antenna on EV board Step 2: Assemble EV board (+antenna) on set. Step 3: Test it like this picture which explains how to do it

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