



*The Power of Linking Together*

**ABRACON  
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**Abracon PTM  
Introduction to AMCA Series  
Ceramic Multilayer Chip Antennas**

**Crystals  
Oscillators  
Filters  
Precision Timing  
Inductors**



# AMCA Series Multilayer Chip Antennas

## Purpose

To introduce AMCA Series, Multilayer Chip Antennas.

## Objective

Present the advantage, performance and applications of Abracon AMCA Series.

## Content

22 pages

## Learning Time

25 minutes

Welcome to Abracon's AMCA Series; Ceramic Multilayer Chip Antenna Training Module. This training session will provide an overview of the key features and benefits; as well as, discuss the applications of this product series.

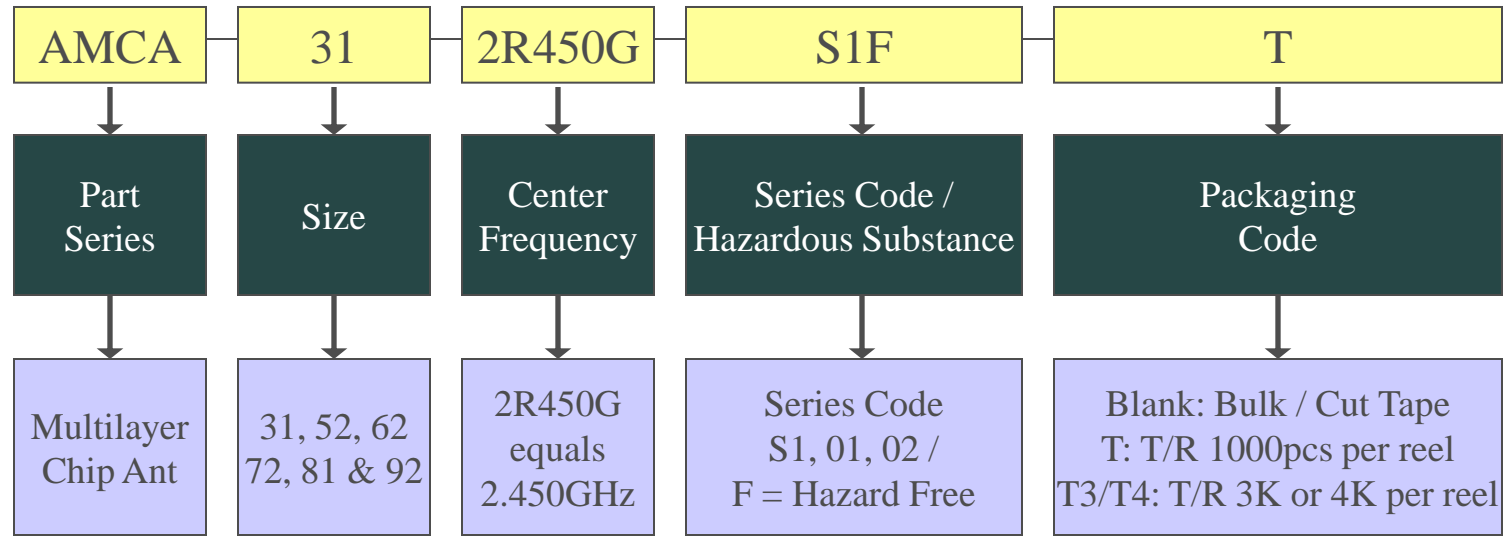
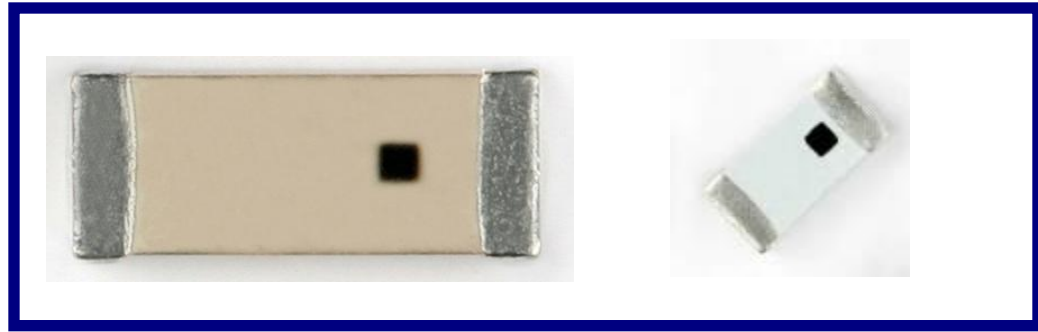
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# Product - AMCA Series Ceramic Multilayer Chip Antennas

## Abracon AMCA Series-Part Numbering



The AMCA Series offers a range of Multilayer Chip Antennas as described by their part number code

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# Abracon AMCA Series - Part Numbering & Descriptions

| Part No                    | Description / Band                     | Center Frequency          | Size              |
|----------------------------|--|---------------------------|-------------------|
|                            |  | Bandwidth (MHz)           |                   |
| <b>AMCA31-2R450G-S1F-T</b> | Chip Antenna – WLAN / WiFi / Bluetooth | 2450MHz<br>2405 ~ 2495MHz | 3.1 x 1.6 x 1.2mm |
| <b>AMCA31-2R800G-S1F-T</b> | Chip Antenna WLAN                      | 2800MHz<br>2750~ 2850MHz  | 3.1 x 1.6 x 1.2mm |
| <b>AMCA52-2R350G-S1F-T</b> | Chip Antenna WLAN                      | 2350MHz<br>2275 ~ 2425MHz | 5.2 x 2.1 x 1.1mm |
| <b>AMCA52-2R510G-S1F-T</b> | Chip Antenna WLAN                      | 2510MHz<br>2410 ~ 2610MHz | 5.2 x 2.1 x 1.0mm |

The ACMA Series covers a broad range of RF bands including IEEE 802.11b/g & IMT, and WiMax bands. The term IMT ( International Mobile Telecommunications) is the root name which encompasses both IMT-2000 and IMTAdvanced (4G) collectively.

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# Abracon AMCA Series - Part Numbering & Descriptions

| Part No             | Description / Band | Center Frequency          | Size              |
|---------------------|--------------------|---------------------------|-------------------|
|                     |                    | Bandwidth (MHz)           |                   |
| AMCA52-2R540G-S1F-T | Chip Antenna WLAN  | 2540MHz<br>2440 ~ 2640MHz | 5.2 x 2.1 x 1.0mm |
| AMCA52-2R710G-S1F-T | Chip Antenna WLAN  | 2710MHz<br>2610~ 2810MHz  | 5.2 x 2.1 x 1.0mm |
| AMCA52-2R780G-S1F-T | Chip Antenna WLAN  | 2780MHz<br>2680 ~ 2880MHz | 5.2 x 2.1 x 1.0mm |
| AMCA62-2R640G-01F-T | Chip Antenna WLAN  | 2640MHz<br>2540 ~ 2740MHz | 6.0 x 2.0 x 1.0mm |

IMT 5.384A describes the bands, or portions of the bands, 1710 ~ 1885 MHz, 2 300 ~ 2400 MHz and 2 500 ~ 2 690 MHz. These are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance resolution 223 (Rev.WRC-07)  
The AMCA series covers the upper two IMT bands.

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# Abracon AMCA Series - Part Numbering & Descriptions

| Part No             | Description / Band | Center Frequency          | Size              |
|---------------------|--------------------|---------------------------|-------------------|
|                     |                    | Bandwidth (MHz)           |                   |
| AMCA72-2R470G-S1F-T | Chip Antenna WLAN  | 2470MHz<br>2370 ~ 2570MHz | 7.0 x 2.0 x 1.0mm |
| AMCA72-2R860G-02F-T | Chip Antenna WLAN  | 2860MHz<br>2760~ 2960MHz  | 7.0 x 2.0 x 1.0mm |
| AMCA81-3R010G-S1F-T | Chip Antenna WLAN  | 3010MHz<br>2910 ~ 3110MHz | 8.0 x 1.0 x 1.0mm |
| AMCA92-2R660G-S1F-T | Chip Antenna WLAN  | 2660MHz<br>2410 ~ 2610MHz | 9.0 x 2.0 x 1.0mm |

The AMCA antennas also covers portions of the WiMax (IEEE-802.16.) bands, that operates globally between 2-11 GHz (3.5 GHz in Europe) for Fixed WiMax and 2-6GHz for Mobile WiMax. They also cover several TDD LTE bands. In both cases the AMCA antenna are applicable for the user equipments.

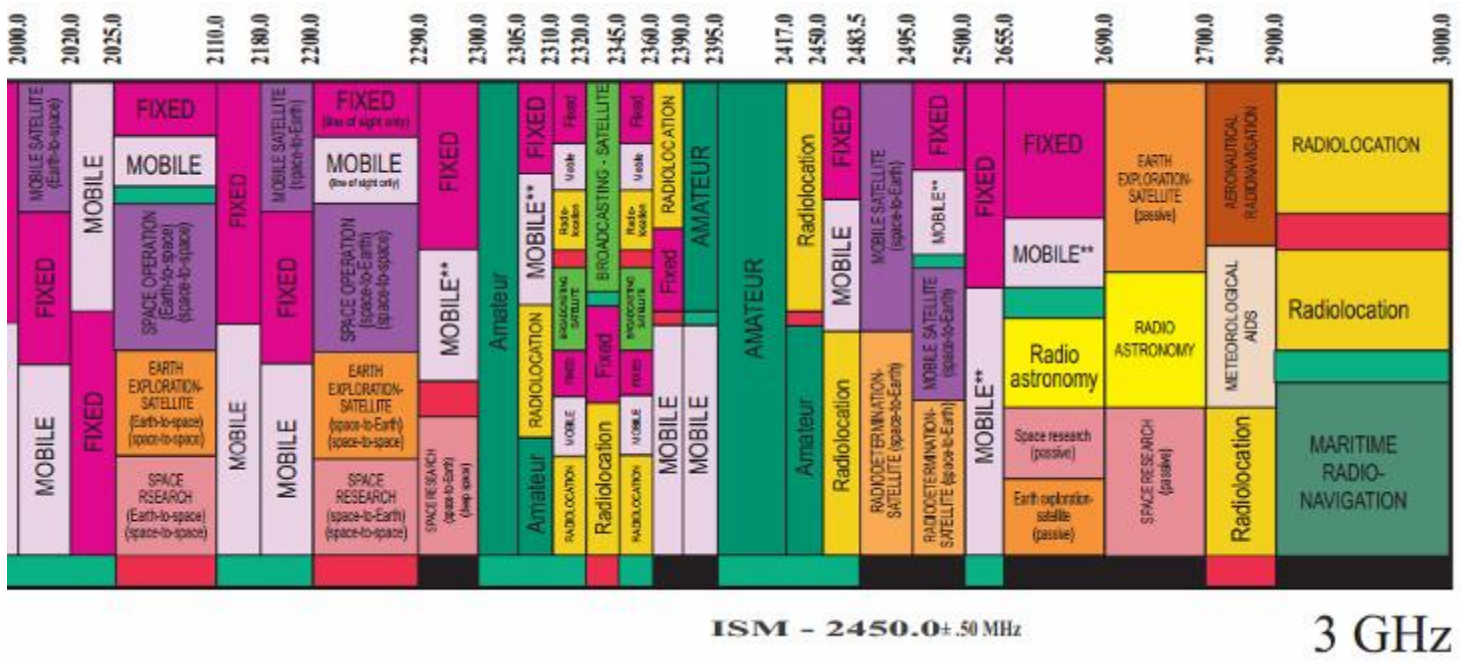
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# USA Radio Frequency Allocation from 2GHz to 3GHz

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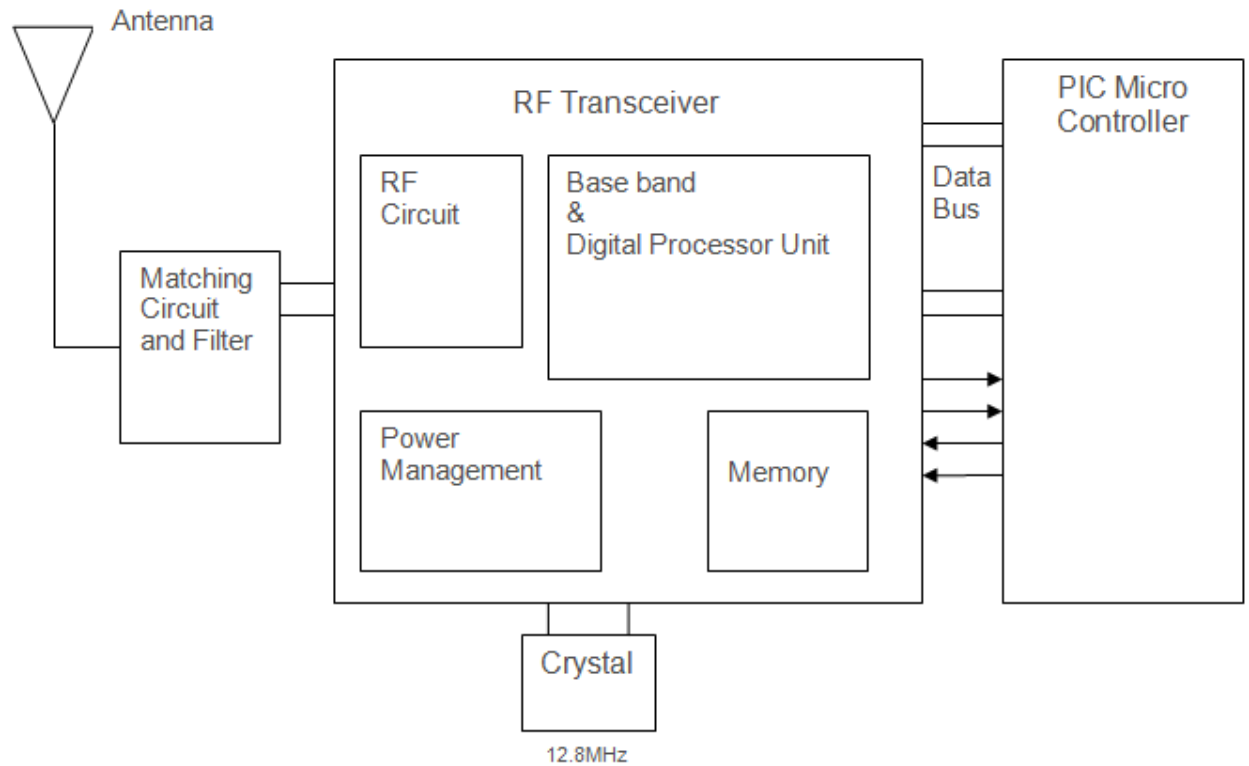
## USA RF Allocation Spectrum:

The chart shows the relevant section of US Radio Frequency Allocation between 2GHz and 3GHz. It can be seen that a wide range of Fixed and Mobile bands are available across this frequency bandwidth. The AMCA Series covers many bands used by IMT User Equipment (UE) applications (fixed and mobile).





# Example of Block Diagram WiFi / WLAN TCVR



Block diagram shows application of **Chip Antenna** with a RFIC.

In this WiFi or ISM example; the 2.45GHz antenna provides the transmission and reception of signals. In many handheld solution the choice of antenna will be a ceramic chip type. Abracon also provides other BOM elements for example SAW, Balun, BPF, as well as Crystals or Resonators.

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# Ceramic Multilayer Chip Antenna Technology

## What are Chip Antennas?

Chip antennas come in various sizes and are often seen as small ceramic blocks with minimal metal artwork and SM pads into which the signal is launched.

## Multilayer Ceramic Technology

The AMCA Series are made from LTCC (Low Temperature Co-fired Ceramic). This technology is the same used in multilayer inductors and capacitors, allowing the devices to be small but especially low profile. The metallization is all within the devices, so only the pads and can be seen at the ends of the package.



Chip Antennas are small ceramic blocks, either solid or multilayer; this type are the latter, and have been manufactured using LTCC technology, so allowing exceptional low profiles. This allows for compact very low profile devices.

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# Ceramic Multilayer Chip Antenna Technology

## Size of Multilayer Chip Antennas

- Antenna size is one of the determining factors to achieve **Gain** and **Bandwidth** requirements that are important for radio system design.
- A reduction of size while maintaining efficiency leads to a reduction in bandwidth; conversely maintaining efficiency and bandwidth leads to a lower gain <sup>(1)</sup>.

| Part Number                  | Code / Size (mm)        | Bandwidth (MHz) | Peak Gain (dBi)        |
|------------------------------|-------------------------|-----------------|------------------------|
| AMCA <b>31</b> -2R450G-S1F-T | (31)<br>3.2 x 1.6 x 1.2 | 90MHz           | +0.5dBi                |
| AMCA <b>52</b> -2R350G-S1F-T | (52)<br>5.2 x 2.1 x 1.0 | 200MHz          | +2.5dBi                |
| AMCA <b>62</b> -2R640G-01F-T | (62)<br>6.0 x 2.0 x 1.0 | 200MHz          | +2.6dBi                |
| AMCA <b>72</b> -2R470G-S1F-T | (72)<br>7.0 x 2.0 x 1.0 | 200MHz          | +2.7dBi                |
| AMCA <b>81</b> -3R010G-S1F-T | (81)<br>8.0 x 1.0 x 1.0 | 200MHz          | +2.0dBi <sup>(2)</sup> |
| AMCA <b>92</b> -2R660G-S1F-T | (92)<br>9.0 x 2.0 x 1.0 | 200MHz          | +3.0dBi                |

(Note <sup>(1)</sup>: Subject to similar frequency bands and the same dielectric constant)  
(Note <sup>(2)</sup>: Lower gain here is subject to higher operating frequency 3.010GHz)

The size of the Chip Antennas is determined by the dielectric constant (Er) of the Ceramic. Designers need to consider trade-offs of board space, gain and bandwidth requirements when picking an antenna.

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# Key Features of Multilayer Chip Antennas

- o Multilayer Chip Antennas offer...
- o Use of multilayer technology offers compact design.
- o Available across a range of bands, makes these ideal for multi-band applications like Mobile Phone / Tablets / WLAN / WiMax / LTE
- o Multilayer technology provides exception low profile, light weight, range of form factor suitable for compact applications.
- o The range of form factors gives designers scope to exploit excellent gain and directivity performance relative to their size.
- o Ease of matching during application development.
- o Better SAR response than PCB traces .
- o Improved isolation allowing multiple antenna applications.
- o Omni-directional radiation highly suitable for mobile communications.

Multilayer Chip Antennas offer a range of advantages to designers who have restricted space or cannot afford an external antenna. Key features include low profile compact designs, and choice of form factors giving designers flexibility to trade size, efficiency, & gain to meet system requirements while minimizing antenna profile.

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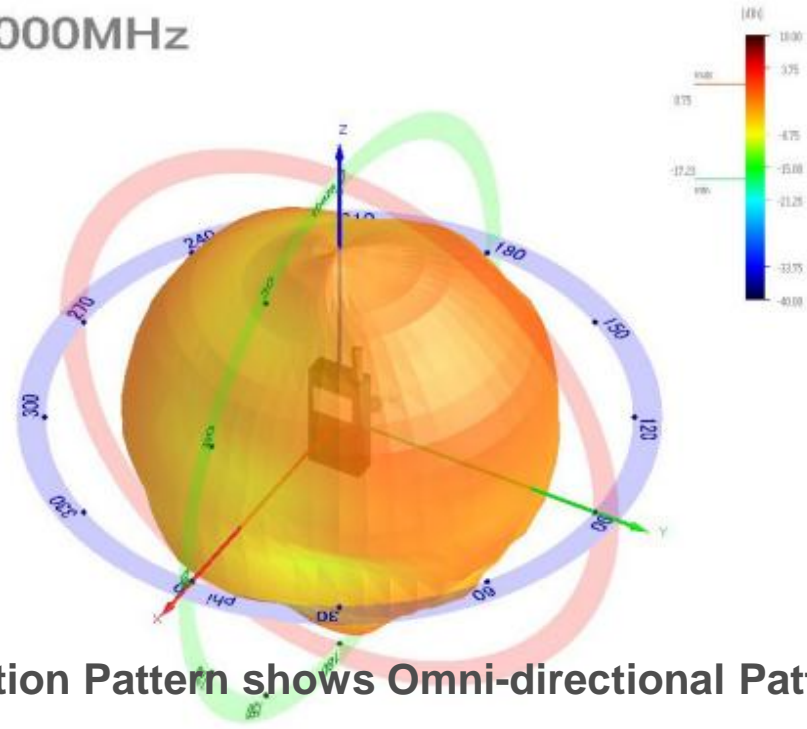
# Antenna Radiation Patterns

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## 3D Radiation Pattern

2445.000MHz



3D Radiation Pattern shows Omni-directional Pattern

| No. | Freq.    | Pwr Sum |         |          |        | H(φ=90) |         |          |        | E1(φ=0) |         |          |         | E2(φ=90) |         |          |        |         |
|-----|----------|---------|---------|----------|--------|---------|---------|----------|--------|---------|---------|----------|---------|----------|---------|----------|--------|---------|
|     |          | Eff[%]  | Avg[dB] | Peak[dB] | θ[deg] | φ[deg]  | Avg[dB] | Peak[dB] | φ[deg] | BW[deg] | Avg[dB] | Peak[dB] | θ[deg]  | BW[deg]  | Avg[dB] | Peak[dB] | θ[deg] | BW[deg] |
| 1   | 2400.000 | 32.82   | -4.84   | -0.42    | 135.00 | 195.00  | -4.91   | -2.19    | 150.00 | 130.57  | -5.76   | -2.53    | -135.00 | 40.19    | -4.43   | -1.55    | 30.00  | 101.04  |
| 2   | 2425.000 | 34.77   | -4.59   | -0.33    | 135.00 | 195.00  | -4.33   | -2.14    | 210.00 | 135.20  | -5.50   | -2.31    | -135.00 | 38.97    | -4.20   | -1.66    | 30.00  | 115.60  |
| 3   | 2445.000 | 44.89   | -3.48   | 0.60     | 135.00 | 195.00  | -3.02   | -0.71    | 210.00 | 132.38  | -4.54   | -1.32    | -135.00 | 42.79    | -3.18   | -0.66    | 60.00  | 123.04  |
| 4   | 2465.000 | 31.90   | -4.96   | -1.03    | 135.00 | 195.00  | -4.41   | -1.97    | 210.00 | 54.47   | -6.02   | -2.65    | -135.00 | 46.22    | -4.77   | -2.21    | 60.00  | 118.75  |
| 5   | 2485.000 | 30.51   | -5.16   | -1.28    | 135.00 | 195.00  | -4.60   | -2.17    | 210.00 | 47.55   | -6.09   | -3.03    | -135.00 | 48.37    | -5.07   | -2.58    | 60.00  | 115.82  |

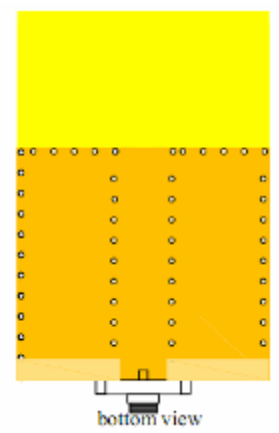
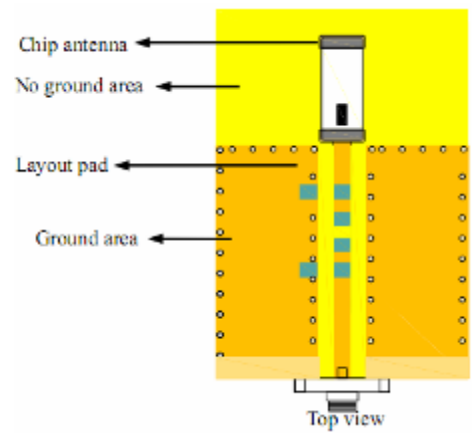
The diagram shows the omni-directional 3D radiation patter of a typical Chip Antenna. This provides 360 degree coverage, and is suited to handheld devices.



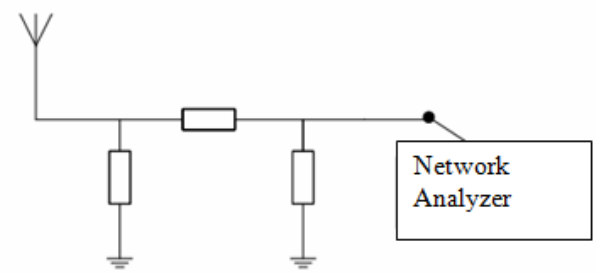


# Typical Antenna PCB Matching

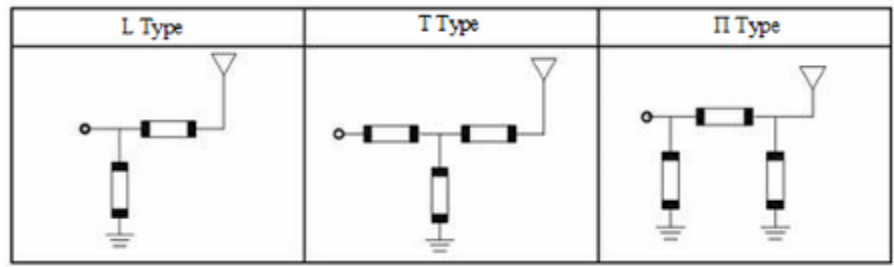
Chip antennas should be matched within the environment of the final product. Normally this process can be done with inductors and / or capacitors.



Electrical Performance with matching circuit:



Passive Test with Network Analyzer



Note: It is recommended to pre-place the  $\pi$ -type circuit layout that offers full flexibility to match the antenna to 50 Ohms, in the final product layout. Depending on matching, NC may apply to certain components in the matching configurations above.

The diagram shows a typical pcb layout for a chip antenna, with matching components. Typically the antenna will need a no-ground region / keep out area. Matching should be done in final production environment.  $\pi$ -type circuit layout should be adopted for flexibility.

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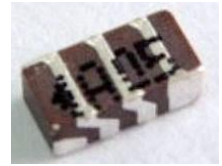


# Comparison between Dielectric & LTCC Multilayer Chip Antennas

- ABRACON offers both Dielectric and LTCC Multilayer Chip antennas from the **ACA** and **AMCA** series respectively.

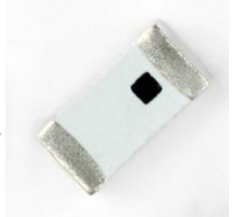
## Dielectric Chip Antennas: ACA series

- Made from a solid ceramic block onto which silver is printed or sprayed to make an antenna pattern. This might take the form of a meandering line of silver metallization to create a helical type antenna, (see below).
- Process scalable based on block size, suitable for low to high volumes.
- More costly, approximately 50%
- Higher gain for same size block



## LTCC Chip Antennas: AMCA series

- These are made from several layers of dielectric sheets, that are pressed then fired. The multilayer technique allows metallization on each layer that are joined internally with via holes. So in this process the helical pattern would be contained internally across the layers.
- Lower cost
- Lower gain for same size compared to dielectric types.
- Wide range of size formats, all very low profile.
- Process suited to very high volumes



Abraccon offers both Dielectric and LTCC multilayer chip antennas. The dielectric types have higher gains & costs compared to LTCC types, that offer wider range of sizes, very low profiles and lower costs.

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# What RF Applications need Chip Antenna



Mobile Phones  
Tablets  
Mobile Gaming

Bluetooth

WLAN  
802.11b/g  
Zigbee  
802.15

IMT and WiMax Bands  
TDD LTE Bands  
And Other Apps

2.45GHz / 2.47GHz  
AMCA31-2R450G-S1F-T  
AMCA72-2R470G-S1F-T

ALL REMAINING PARTS

Chip Antennas are useful for mobile wireless systems where a compact solution is required

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# Applications for Chip Antennas

- o Chip Antennas are used extensively by the mobile phone manufacturers, but these tier 1 customers are not our targets
  
- o **Bluetooth Applications:**
  - o Bluetooth exists in many products, such as telephones, tablets, media players, and gaming like Lego Mindstorms NXT, Playstation 3, PS Vita, Nintendo Wii, and HD Headsets, Modems and watches:
  
  - o Bluetooth Headsets / Intercoms
  - o Bluetooth Audio Headsets
  - o Keyboards / Mouse
  - o Games Consoles / Controllers
  - o Wireless bridge between two Industrial Ethernet (e.g. PROFINET) networks.
  - o Short range transmission of health sensor data from medical devices to mobile phone, or dedicated “Telehealth” devices.
  - o Personal security applications – tags

The Bluetooth technology offers a wide selection of applications involved with Bluetooth enabled devices.

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# Applications for Chip Antennas

- o **WiFi Applications: The “Internet of Things”**
  - o The number of Internet-connected devices in the world in 2011 was estimated at 20 billion by 2020 this is expected to rise to 50 billion devices.
  - o Networking
  - o Consumer Electronics
  - o Computing and Peripherals
  - o Headsets
  - o Automotive and Transport
  - o Health & Fitness
  - o Smart Energy
  - o Industrial Communications

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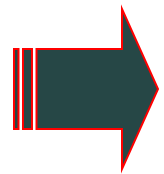
The “Internet of Things” offers an increasing wide application of connected or controlled WiFi solutions. A wide selection of WiFi certified product exist, and offer opportunities for Chip Antennas.



# Applications for Chip Antennas

## **IMT Standardization:**

IMT-2000 / IMT Advanced:



IMT Standards Drives Technology and Telecom Operators to invest in infrastructure

## **IMT Applications:**

- o **Mobile Health**
  - Easy to carry devices
  - Better coverage
  - Backhaul capability for body sensor devices
- o **Smart Energy**
  - Smart Appliances
  - Programmable wireless connected thermostats
  - Adoption of smart energy devices in medium to dense residential areas
- o **Smart City**
  - Telematics
  - Environmental control
  - Public safety (webcam monitoring)
- o **Architecture of Internet of Things**
  - Ubiquitous wireless Connected World

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# Applications for Chip Antennas

## WiMax - 802.16 - Worldwide Interoperability for Microwave Access

WiMax is short for Worldwide Interoperability for Microwave Access. It is a metropolitan wireless standard ratified by the IEEE (Institute of Electrical and Electronics Engineers) under the name IEEE-802.16.

| Standard                     | Frequency                       | Speed  |
|------------------------------|---------------------------------|--------|
| Fixed WiMax<br>(802.16-2004) | 2-11 GHz<br>(3.5 GHz in Europe) | 75Mbps |
| Mobile WiMax<br>(802.16e)    | 2-6 GHz                         | 30Mbps |

The AMCA antenna can be used in WiMax User Equipment (UE) devices, like dongles, laptops, mobile wireless.

WiMax standard is a metropolitan wireless standard. The AMCA chip antennas cover global bands for WiMax user equipments. They can be used in dongles, mobiles and wireless devices to connect to the internet.

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# Applications for Chip Antennas

## **E-UTRA and LTE-Advanced**

The range of AMCA antenna cover certain E-UTRA TDD bands (LTE), between 2.3GHz to 3.6GHz

| LTE Band | Frequency (MHZ) | Duplex | Common Name  | Antenna PN          | Antenna B/W (MHz) |
|----------|-----------------|--------|--------------|---------------------|-------------------|
| 38       | 2570 - 2620     | TDD    | IMT-E / 2600 | AMCA92-2R660G-S1F-T | 1660 - 3660       |
| 40       | 2300 - 2400     | TDD    | 2300         | AMCA52-2R350G-S1F-T | 2275 - 2425       |
| 42       | 3400 - 3600     | TDD    | 3500         | AMCA81-3R010G-S1F-T | 2010 - 4010       |

The AMCA antenna can be used in WiMax User Equipment (UE) devices, like dongles, laptops, mobile wireless.

The AMCA chip antennas cover several of the E-UTRA and LTE-Advanced bands, and can be used in user equipments like dongles, or other LTE equipments covering these bands.

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# Cross Reference Guide

| ABRACON             | MURATA           | YAGEO (PHYCOMP)   | TAIYO YUDEN    | JOHANSON TECHNOLOGY Inc | ANTENOVA |
|---------------------|------------------|-------------------|----------------|-------------------------|----------|
| AMCA31-2R450G-S1F-T | ANCV12G44SAA127  | CAN4311712002451K | AH316M245001-T | 2450AT42A100            | A10192-L |
| AMCA31-2R800G-S1F-T | LDA212G8610K-285 |                   |                |                         |          |
| AMCA52-2R350G-S1F-T |                  |                   | AH104F2350S1-T |                         |          |
| AMCA52-2R510G-S1F-T |                  |                   |                | 2500AT43A0100           |          |
| AMCA52-2R540G-S1F-T |                  |                   | AH104F2550S1-T |                         |          |
| AMCA52-2R710G-S1F-T | 2500AT43A0100    |                   |                |                         |          |
| AMCA52-2R780G-S1F-T |                  |                   |                |                         |          |
| AMCA62-2R640G-01F-T | LDA212G4410K-283 |                   | AH104F2650S1-T | 2600AT44A0600E          |          |
| AMCA72-2R470G-S1F-T |                  |                   |                |                         |          |
| AMCA72-2R860G-02F-T | LDA212G8610K-285 |                   |                |                         |          |
| AMCA81-3R010G-S1F-T | LDA313G0313F-240 |                   |                |                         |          |
| AMCA92-2R660G-S1F-T |                  |                   |                | 2650AT43A0100E          |          |

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The table summarizes the best matches offered by the ACA series to other antenna company products. Products are alternatives and may not be a drop-in solution, so please refer to the specifications.



# Antenna Performances

| P/N                 | Size          | VSWR Max | Gain – Peak / Avg | Qty/Reel | L/T  |
|---------------------|---------------|----------|-------------------|----------|------|
| AMCA31-2R450G-S1F-T | 3.2x1.6x1.2mm | <2.0 max | 0.5 / -1.0dBi     | 1k & 3K  | 8Wks |
| AMCA31-2R800G-S1F-T | 3.2x1.6x1.2mm | <2.0 max | 0.5 / -1.0dBi     | 1k & 3K  | 8Wks |
| AMCA52-2R350G-S1F-T | 5.2x2.1x1.1mm | <2.0 max | 2.5 / 0.5dBi      | 1K & 4K  | 8Wks |
| AMCA52-2R510G-S1F-T | 5.2x2.1x1.0mm | <2.0 max | 2.5 / 0.5dBi      | 1K & 4K  | 8Wks |
| AMCA52-2R540G-S1F-T | 5.2x2.1x1.0mm | <2.0 max | 2.5 / 0.5dBi      | 1K & 4K  | 8Wks |
| AMCA52-2R710G-S1F-T | 5.2x2.1x1.0mm | <2.0 max | 2.5 / 0.5dBi      | 1K & 4K  | 8Wks |
| AMCA52-2R780G-S1F-T | 5.2x2.1x1.0mm | <2.0 max | 2.5 / 0.5dBi      | 1K & 4K  | 8Wks |
| AMCA62-2R640G-01F-T | 6.0x2.0x1.0mm | <2.0 max | 2.6 / 0.7dBi      | 1K & 4K  | 8Wks |
| AMCA72-2R470G-S1F-T | 7.0x2.0x1.0mm | <2.0 max | 2.7 / 1.0dBi      | 1K & 4K  | 8Wks |
| AMCA72-2R860G-02F-T | 7.0x2.0x1.0mm | <2.0 max | 2.7 / 1.0dBi      | 1K & 4K  | 8Wks |
| AMCA81-3R010G-S1F-T | 8.0x1.0x1.0mm | <2.0 max | 2.0 / 0.5dBi      | 1K & 4K  | 8Wks |
| AMCA92-2R660G-S1F-T | 9.0x2.0x1.0mm | <2.0 max | 3.0 / 1.0dBi      | 1K & 4K  | 8Wks |

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The table summarizes the suggested the technology advantages of size, efficiency and gain offered by the AMCA Series.

Thank You for your Kind Attention

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