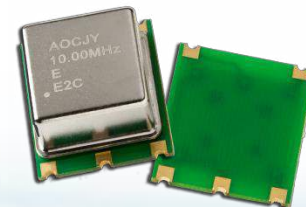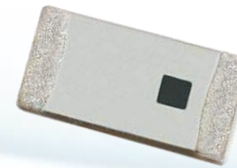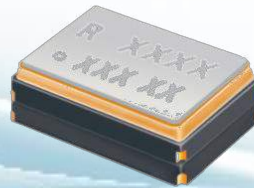# RFID Tags and Readers

RFID Tagging

- RFID tagging is an ID system for identification and tracking purposes that uses radio frequency identification devices.

- An RFID tagging system consists of the tag, a read/write or only read device, and a system application for data collection, processing, and transmission.

- RFID tags consist of minimum two parts: an integrated circuit and an antenna for receiving and transmitting the signal. The tag information is stored in a non-volatile memory.
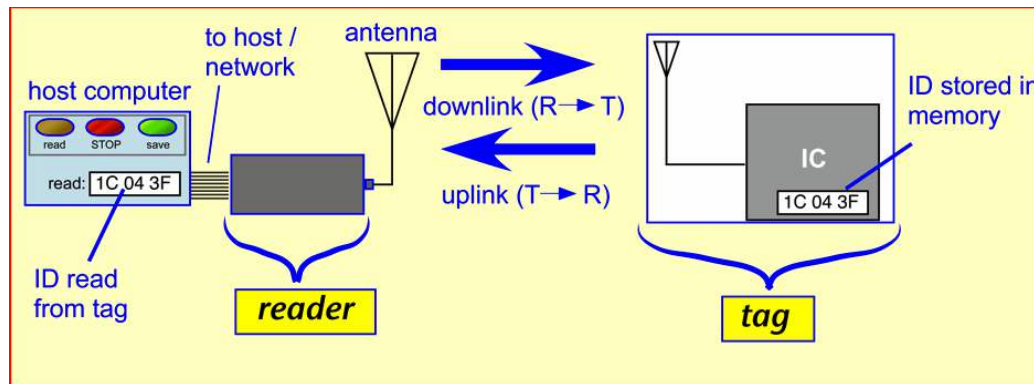
Types of RFID Tags

- RFID tags that include power source are known as active tags versus those without a power source which are passive tags.

- A passive tag is activated momentarily by the radio frequency (RF) scan of the reader. The electrical current is just enough for transmission of an ID number.

- Abracon's RFID Tag series includes variety of passive ceramic tags without chip which have to be matched with a compatible IC to be utilized.

	ACTIVE RFID	PASSIVE RFID
Advantages	Reads long distance Higher data bandwidth Iniciates Communications	Tag's function doesn't rely on battery Inexpensive Variety in size including small sizes More resistant to damage and harsh environments
Disadvantages	Expensive Can't function without battery Large in size, not for small applications	Communication depends on antenna size and shape Read range is limited Difficulty reading through metal or liquid

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3

RFID System Applications

Some of the many applications of RFID tagging are as following:

- Supply chain management: In fast paste manufacturing, shipping, and distribution environments, RFID tagging can provide real-time data on the status of individual items. Unlike bar code stickers, RFID tags don't require line-of-sight between the tag and the reader.

- Material Management: In large scale construction projects, material management is often the largest project expense. RFID tracking system can significantly reduce search related expenses and time.

- Gas and oil drilling and pipeline management

- Toll collection and contactless payment

RFID Tag Types

- Tag's material and structure are different depending on the end application and environment
- There are three main categories known for RFID Tags.

- **Inlay Tags** occupy 70% of the market. This type of Tag is mainly used in clothing and merchandise management, and can be replaced by bar code. They are low cost and easy to use but can be employed only in metal free and normal temperature.

- **Composite tags** occupy 20% of the market. This type of tag is mainly applied in storage and pipeline management. They can be used in metal environment but have poor performance.

- **Ceramic Tags** occupy 10% of the market. This type of Tag is used in medical equipment, oil and gas pipeline and drilling management which relate to harsh environment. They are small, high temperature and high pressure resistant. However they have narrow bandwidth and long manufacturing cycle.

Inlay Tags

Composite tags

Ceramic Tags

RFID Ceramic Tag Built

- The passive RFID contains two parts: The tag antenna and the chip.
- The Tag antenna is made of a dielectric base and a conductive area.
- The main characteristics of RFID tags are frequency, recognition distance, and the chip agreement and capacity.
- Abracon's RFID tag series are without the chip and need to be matched with their compatible chip before being utilized in end application.
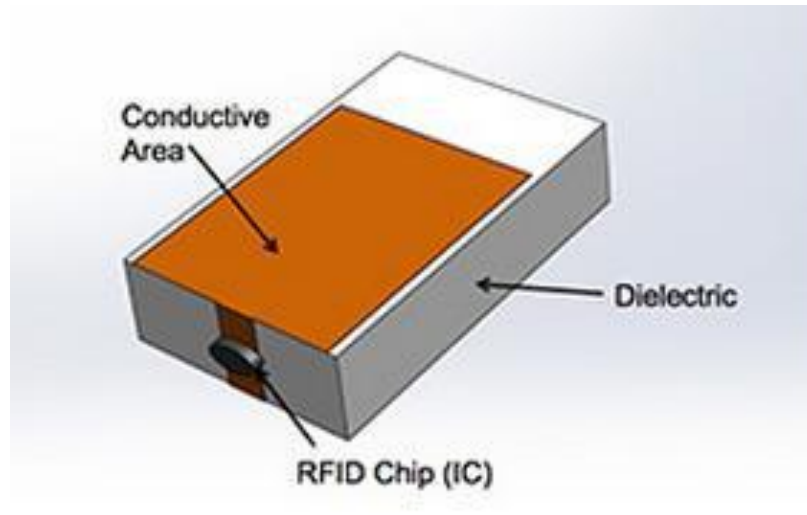
How does communication occur?

- Data between reader and tag are transmitted in half-duplex mode.

- The reader continuously generates a RF carrier wave. When the passive tag is within its read range, this signal powers it.

- The tag responds to the reader by backscatter and the detected electromagnetic field indicates the presence of the tag.

- The time taken for the tag to become fully functional is called the setup time. After this time, the reader requests for read/write access by sending instructions to the tag.

- The demodulator recovers the received data stream.

- After demodulation of the received instructions and handshaking, the information stored in the tag is transmitted back to the reader by backscattering.

- After all of the read/write operations are completed, the reader acknowledges the successful completion of the communication and the tag shuts off.

RFID Tag Installation methods

- TAG antenna should be installed in a housing. 3M adhesive tape or screw can be used way fix the housing on the end product.

- All pictures shown are the finished TAG antenna installed in casing.

- Injection molding is another method for installing the tag antennas. The inject material is mostly resin. The type of resin depends on the project requirements. Different resin requires different injection temperature which depends on the finished product.

Double faced Adhesive Tape

Plastic housing installation

Injection Molding Installation

Chip Types to be accompanied by Abracon Tags

- The Chip type that is compatible with Abracon's RFID tag antenna is international main agreement, EPC Gen 2 (ISO180006C) and the capacity depends on the chip package.

- International main chips Impinj (M4QE), Alien (H3) and NXP are the chip types used with the Abracon ceramic tags. H3 and M4QE are the market mainstream which are utilized on 90% of Abracon RFID tags.
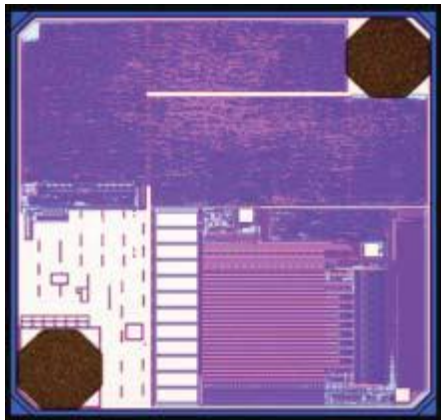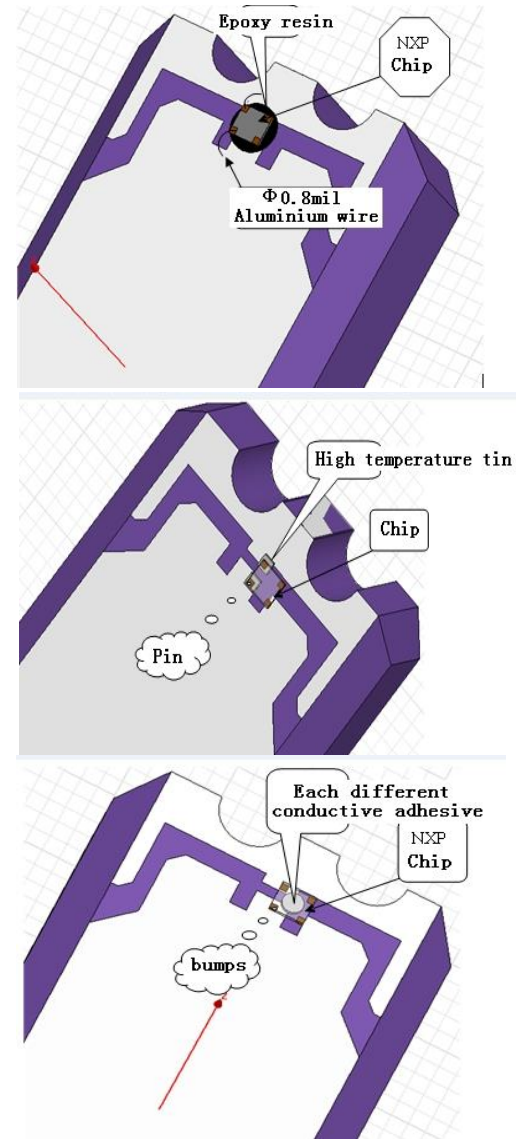
Gen 2 RFID Tag Memory Types

- Gen 2 RFID tags are built of an antenna and a chip (IC). The ICs for Gen 2 tags contain four types of memory.

- Reserved Memory stores the kill password and the access password (each are 32 bits). The kill password permanently disables the tag (very rarely used), and the access password is set to lock and unlock the tag's read/write capabilities.

- EPC Memory stores the EPC code, or the Electronic Product Code. It has a minimum of 96 bits of writable memory. The EPC memory is what is typically used in most applications if they only need 96 bits of memory.

- TID Memory is used only to store the unique tag ID number by the manufacturer when the IC is manufactured. Typically, this memory portion cannot be changed.

- If the user needs more memory than the EPC section has available, user memory can be utilized. Typically, the extended memory is no more than 512 bits.

Mounting the Chip on the Ceramic Tag

- Bonding, SMT and Flip Chip are the three types of technologies currently being utilized to mount a chip on ceramic RFID tags.

- Abracon's ceramic RFID Tag series are passive and they have to be matched with their compatible chip to be utilized.

- **Bonding technology** is the most used method to mount a chip on ceramic TAGs. Bonding offers high stability and high reliability, but the highest temperature limit is 180°C.

- **SMT technology** is rarely used. It is temperature resistant up to 220°C. The reliability is not as good as Bonding method and the cost is higher because of special silver material requirement.

- **Flip chip technology** is the mainstream technology for PET flexible ceramic TAGs. The advantage is higher temperature resistance which can reach up to 300°C. However the reliability is the worst of all three methods.

Epoxy resin
NXP Chip
Φ0.8mil Aluminium wire

High temperature tin
Chip
Pin

Each different conductive adhesive
NXP Chip
bumps

ART923X855406TX02

Size: 85*54*0.635mm
Frequency: 865~868MHz /902~928MHz
Recognition distance: 8.5m（Fixed reader）
Agreement: EPC
Capacity: EPC - 96bits
                        User - 512bits
                        TID - 64bits

The ceramic type used in this type of tag is microwave material with dielectric constant of 10.
This type of tag is electronic card which is suitable for the long distance management, vehicle management, license plate management, ETC charges and etc.

ART868X130903TX13

Size: 13*9*3mm
Frequency: 865~868MHz /902~928MHz
Identification Distance: 1.5m（Fixed reader）
Agreement: EPC
Capacity: EPC - 96bits
                                        User - 512bits
                                         TID - 64bits

Microwave ceramic material with dielectric constant of 130.
A label applied to electronic control of small items can be attached to the metal surface or embedded within the metal.
This model is suitable for mold management, firearms management and office management.
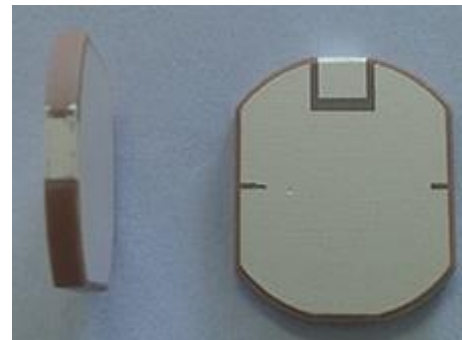
ART868X2117225TX21

Size: 21*17*2.25mm
Frequency: 865~868MHz /902~928MHz
Recognition distance: 2.2m（Fixed reader）
Agreement: EPC
Capacity: EPC - 96bits
                  User - 512bits
                  TID - 64bits

Microwave ceramic matrix material with dielectric constant of 92.
Suitable for valuables management, can be attached to a metal surface or embedded within the metal. For example: pipes crossing under ground management, water table management, license management, office management, and etc.

ART868X25275YZ25

Size: 25*25*2.75mm
Frequency: 865~868MHz /902~928MHz
Recognition distance: 3.0m（Fixed reader）
Agreement: EPC
Capacity: EPC - 96bits
                        User - 512bits
                        TID - 64bits

Microwave ceramic matrix material with dielectric constant of 68.
This type of tag can be attached to a metal surface or be embedded within the metal. For example: container management, warehouse management and oil and gas pipeline management.

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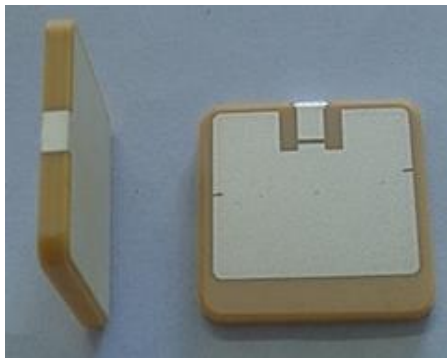
Notes

- RFID Tag can not be completely wrapped by metal. At least one side should be exposed to non-metal material to be used for signal transmission. The top side of the tag can be covered by not metal housing.

- Along with the increase of dielectric constant, the thickness increases and the frequency decreases.

- RFID Tag is attached to a metal surface, the frequency will increase along with the increase of metal surface.

- RFID Tag cannot radiate signal if it is in the liquid or when the surface is covered by liquid.

- Either the earth or human could absorb radiation signal of the Tag.

- The surrounding area of the Tag should not have any other strong radiating device with mutual interference.

Passive RFID Reader Applications

- Built in antenna in portable hand held read and write device. The feature of this type of device are portability, high performance and small size.

- Built-in antenna in semi-fixed read and write devices. Semi-fixed read and write devices are between handheld and fixed. They can dismounted and have high demand for passive RFID Readers.

- Built-out antenna in multiport read and write devices. The antenna has built-out structures and one read and write device can connect to several antennas.

ARRUN5

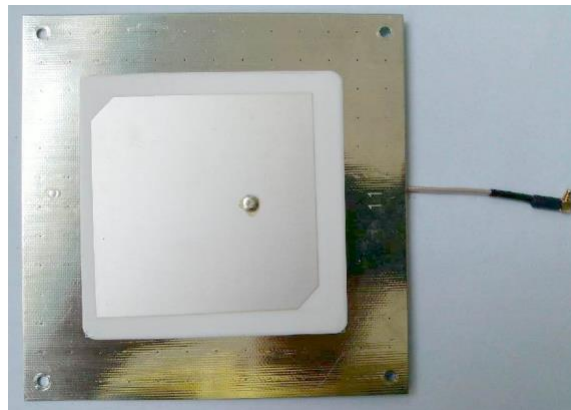Size: 80*80*6mm
Frequency: 865~868MHz /902~928MHz
Bandwidth: 26MHz
VSWR: <1.3
Gain: 5.5dBi
Polarization: RHCP

The performance of this internal RFID reader is compatible with standard external type while the antenna size is much smaller in comparison.

It can be applied to the high demand built-in applications such as refrigerator, internal identification label and entrance guard detection.

ARRTN5

Size: 62.5*62.5*6mm
Frequency: 865~868MHz /902~928MHz
Bandwidth: 10MHz
VSWR: <1.3
Gain: 4.0dBi
Polarization: RHCP

The performance of this internal RFID reader is compatible with standard external type while the antenna size is much smaller in comparison.

It can be applied to the high demand built-in applications such as refrigerator, internal identification label and entrance guard detection.
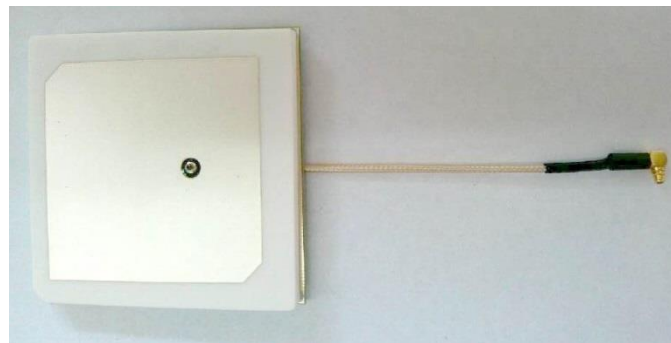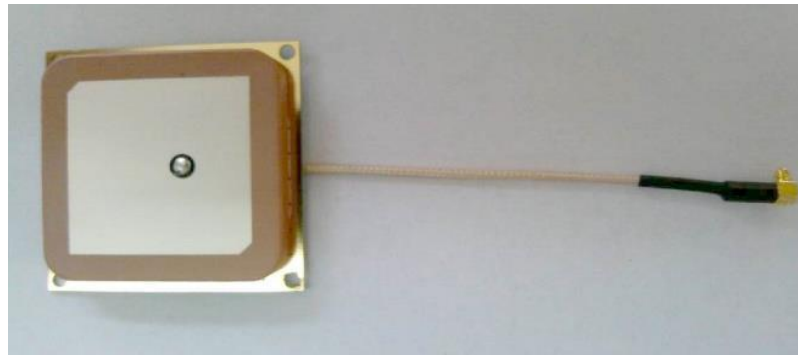
ARRSN5

Size: 45*45*6mm
Frequency: 865~868MHz /902~928MHz
Bandwidth: 8MHz
VSWR: <1.3
Gain: 3.0dBi
Polarization: RHCP

The advantage of this ceramic antenna with dielectric constant 20 is high performance, small size and light weight. It can be utilized in a variety of handheld devices requiring to read and write data.

ARRRN5

Size: 36*36*4mm
Frequency: 865~868MHz /902~928MHz
Bandwidth: 4MHz
VSWR: <1.3
Gain: 2.0dBi
Polarization: RHCP

This small size antenna with dielectric constant of 39.4 has a narrow bandwidth and covers the full band in Europe, North America, only to the center frequency 915MHz or 922.5MHz in Asia. It is suitable for small portable readers, such as: alcohol anti-counterfeiting devices.
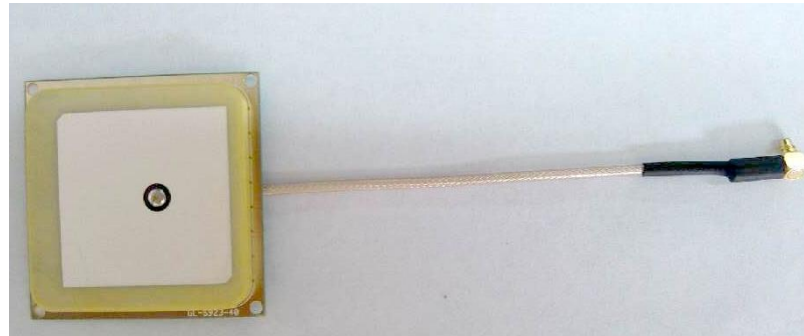
No.	Abracon Part #	Product center Freq.	Size	Product Application	Gain(dBi)	GND Plane Size
1	ART868X130903TX13	868MHz	13*9*3mm	RFID Tag (EU)	1.0dBi	70x70mm
2	ART868X2117225TX21	868MHz	21*17*2.25mm	RFID Tag (EU)	1.0dBi	70x70mm
3	ART868X25275YZ25	868MHz	25*25*2.75mm	RFID Tag (EU)	1.0dBi	70x70mm
4	ART915X130930TX13	915MHz	13*9*3mm	RFID Tag (USA)	1.0dBi	70x70mm
5	ART915X2117225TX21	915MHz	21*17*2.25mm	RFID Tag (USA)	1.0dBi	70x70mm
6	ART915X25275YZ25	915MHz	25*25*2.75mm	RFID Tag (USA)	1.0dBi	70x70mm
7	ART923X855406TX02	923MHz	85*54*0.635mm	RFID Tag (Asia)	3.0dBi	70x70mm
8	ART923X1015YZ10	923MHz	Φ10*1.5mm	RFID Tag (Asia)	-2.0dBi	70x70mm
9	ARRCN5-868.000MHz	868MHz	18*18mm	RFID Reader (EU)	-5.0	70x70mm
10	ARRAN5-868.000MHz	868MHz	25*25mm	RFID Reader (EU)	0.5	70x70mm
11	ARRRN5-868.000MHz	868MHz	36*36mm	RFID Reader (EU)	1.5	70x70mm
12	ARRSN5-868.000MHz	868MHz	45*45mm	RFID Reader (EU)	2.5	70x70mm
13	ARRTN5-868.000MHz	868MHz	63.5*63.5mm	RFID Reader (EU)	3.5	70x70mm
14	ARRUN5-868.000MHz	868MHz	80*80mm	RFID Reader (EU)	5.5	70x70mm
15	ARRCN5-915.000MHz	915MHz	18*18mm	RFID Reader (USA)	-5.0	70x70mm
16	ARRAN5-915.000MHz	915MHz	25*25mm	RFID Reader (USA)	0.5	70x70mm
17	ARRRN5-915.000MHz	915MHz	36*36mm	RFID Reader (USA)	1.5	70x70mm
18	ARRSN5-915.000MHz	915MHz	45*45mm	RFID Reader (USA)	2.5	70x70mm
19	ARRTN5-915.000MHz	915MHz	63.5*63.5mm	RFID Reader (USA)	3.5	70x70mm
20	ARRUN5-915.000MHz	915MHz	80*80mm	RFID Reader (USA)	5.5	70x70mm