Combination Radio Frequency Identification Transponder (RFID Tag) and Magnetic Electronic Article Surveillance (EAS) Tag

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Related U.S. Application Data

Continuation of application No. 10/985,665, filed on Nov. 10, 2004, which is a continuation of application No. 10/772,221, filed on Feb. 4, 2004, which is a continuation of application No. 09/181,505, filed on Oct. 28, 1998, now abandoned, which is a continuation-in-part of application No. 09/071,413, filed on May 1, 1998, now Pat. No. 5,939,984.
Continuation-in-part of application No. 10/391,515, filed on Mar. 18, 2003, which is a continuation of application No. 09/136,157, filed on Aug. 18, 1998, now Pat. No. 6,535,108, which is a continuation of application No. 08/569,375, filed on Dec. 8, 1995, now Pat. No. 5,812,065, which is a continuation-in-part of application No. 08/514,705, filed on Aug. 14, 1995, now abandoned.

Provisional application No. 60/070,136, filed on Dec. 31, 1997. Provisional application No. 60/102,476, filed on Sep. 30, 1998. Provisional application No. 60/093,088, filed on Jul. 16, 1998.

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Abstract

A combination of a radio frequency identification transponder (RFID Tag) and to a magnetic electronic article surveillance (EAS) device is disclosed. The present invention relates generally to radio frequency identification (RFID) systems, and more specifically to RFID transponders for use in RFID systems and the method for their assembly.
COMBINATION RADIO FREQUENCY IDENTIFICATION TRANSPONDER (RFID TAG) AND MAGNETIC ELECTRONIC ARTICLE SURVEILLANCE (EAS) TAG

CROSS-REFERENCE TO RELATED APPLICATIONS


INCORPORATION BY REFERENCE

[0002] The following US Patents and Patent Applications are hereby incorporated herein by reference in their entirety:

U.S. Patent

[0003]

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<th>Patent No.</th>
<th>Issue Date</th>
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<td>5,521,601</td>
<td>May 28, 1996</td>
<td>Apr. 23, 1995</td>
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<td>5,528,222</td>
<td>Jun. 18, 1996</td>
<td>Sep. 09, 1994</td>
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<td>5,538,803</td>
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<td>5,635,693</td>
<td>Jun. 03, 1997</td>
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<td>Y0994-3215</td>
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U.S. Provisional Patent Applications

[0004]

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<td>60/073,102</td>
<td>Jun. 30, 1998</td>
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<td>60/074,405</td>
<td>Feb. 13, 1998</td>
<td>Y0987-0258P1</td>
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<td>60/078,384</td>
<td>Mar. 17, 1998</td>
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<td>60/093,088</td>
<td>Jul. 16, 1998</td>
<td>33894P1</td>
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[0005] The following further documents are also incorporated herein by reference in their entirety:

IBM Technical Disclosure Bulletin


Literature Reference


PCT Published International Applications

[0008]

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<th>Published Application No.</th>
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<td>WO 96/13793</td>
<td>May 09, 1996</td>
<td>Sep. 20, 1995</td>
<td>Y0994-253 PCT</td>
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The present invention relates to an identification tag and more particularly to an identification tag having a large number of bits of information, where the identification tag has an electronic article surveillance function which is difficult to defeat.

DESCRIPTION OF THE RELATED ART

Radio frequency identification transponders (RFID Tags) have been developed in the last years to take advantage of the fall in semiconductor logic and memory prices. Such tags are available having a single silicon chip attached to a wire or patch antenna. Such tags, however, may be shielded from the high frequency RF used to communicate with the tags. The anti-theft properties of the RFID tags are suspect.

Magnetic electronic article surveillance (EAS) tags are much less easily shielded from the low frequency magnetic detection fields. Such EAS tags as described below, however, have possibilities of storing only a few bits of information.

Some conventional magnetic EAS tags have employed the Barkhausen jump effect. Generally, the Barkhausen effect is characterized by a tendency for magnetization induced in a magnetic material to change in discrete steps as an external magnetic field is increased or decreased. The material is said to be a non-linear magnetic material if the magnetisation of the material is not proportional to the external magnetic field. A large temporal flux change, d\(\Phi\)/dt, occurs when such a step takes place, and a sizable voltage may be induced in a sensing or pickup coil.

For example, U.S. Pat. No. 5,181,020 describes a thin-film magnetic tag having a magnetic thin film formed on a polymer substrate and a method for producing the same. The thin film exhibits a large Barkhausen discontinuity without intentional application of external torsional or tensile stress on use. A particular disclosed use is as a marker or tag for use in an article surveillance system wherein articles may be identified by interrogating the tagged article in a cyclic magnetic field of a predetermined frequency in a surveillance area and detecting a harmonic wave of the magnetic field generated by the tag in the surveillance area. This conventional system is only a single bit element using a single Barkhausen layer with no ability to develop a code to distinguish items.

U.S. Pat. No. 5,313,192 describes another single bit tag which relies on the Barkhausen effect. The tag of this invention is selected to include a first component comprised of a soft magnetic material which constitutes the bulk of the tag. A second component comprised of a semi-hard or hard magnetic material is integral with the first component. The tag is conditioned such that the second component has activating and deactivating states for placing the tag in active and deactivated states, respectively. Such conditioning includes subjecting the composite tag to predetermined magnetic fields during thermal processing steps. By switching the second component between its activating and deactivating states the tag can be switched between its active and deactivated states. A reusable tag with desired step changes in flux which is capable of deactivation and reactivation is thereby realized.

U.S. Pat. No. 4,980,670 describes a one bit magnetic tag formed from a magnetic material having domains with a pinned wall configuration. The resulting hysteresis characteristic for that material is such that upon subjecting the material to an applied alternating magnetic field, the magnetic flux of the material undergoes a regenerative step change in flux (Barkhausen jump) at a threshold value when the field increases to the threshold value from substantially zero and undergoes a gradual change in flux when the field decreases from the threshold value to substantially zero. For increasing values of applied field below the threshold, there is substantially no change in the magnetic field of the material. The tag may be deactivated by preventing the domain walls from returning to their pinned condition by, for example, application of a field of sufficiently high frequency and/or amplitude.

U.S. Pat. No. 4,940,966 describes the use of a plurality of magnetic elements in predetermined associations (e.g., with predetermined numbers of magnetic elements and with predetermined spacings between said elements), for identifying or locating preselected categories of articles. When the articles are caused to move relative to a predetermined interrogating magnetic field, each particular association of magnetic elements gives rise to a magnetic signature whereby the article or category of article carrying each of the predetermined associations can be recognized and/or located.

U.S. Pat. No. 4,660,025 describes a marker for use in an electronic surveillance system. The marker which can be in the form of a wire or strip of magnetic amorphous metal is characterized by having retained stress and a magnetic hysteresis loop with a large Barkhausen discontinuity. When the marker is exposed to an external magnetic field whose field strength, in the direction opposing the instantaneous magnetic polarization of the marker, exceeds a predetermined threshold value a regenerative reversal of the magnetic polarization of the marker occurs and results in the generation of a harmonically rich pulse that is readily detected and easily distinguished.

U.S. Pat. No. 5,175,419 describes a method for interrogating an identification tag comprised of a plurality of magnetic thin wires or thin bands which have highly rectangular hysteresis curves and different coercive forces. The wires or bands are preferably of amorphous material, but means for obtaining the highly rectangular hysteresis curves and different coercive forces are not taught; nor is the concept taught of using a time varying magnetic field superimposed on a ramp field for interrogation.

U.S. Pat. No. 5,729,201 describes an inexpensive multibit magnetic tag is described which uses an array of amorphous wires in conjunction with a magnetic bias field. The tag is interrogated by the use of a ramped field or an ac field or a combination of the two. The magnetic bias is supplied either by coating each wire with a hard magnetic material which is magnetized or by using magnetized hard magnetic wires or foil strips in proximity to the amorphous wires. Each wire switches at a different value of the external interrogation field due to the differences in the magnetic bias field acting on each wire.

The above identified U.S. Patents and the following related U.S. Patents assigned to the assignee of the present invention are hereby incorporated by reference: U.S. Pat. Nos. 5,528,222; 5,550,547; 5,552,778; 5,554,974; 5,538,803; 5,563,583; 5,565,847; 5,606,323; 5,521,601; 5,635,
have electrical conductivity insufficient for high quality antennas, and an alternative most preferred embodiment is to coat the non-linear magnetic material with a good electrical conducting material such as copper, gold, or a conducting polymer. The conducting material need only be as thick as the skin depth of the high frequency RF signals sent to the RFID tag. Such conducting material may be coated on the non-linear magnetic material by coating processes well known in the art such as evaporation, electroplating, or electroless plating.

[0031] FIG. 2 shows a sketch of an RFID tag having a tag antenna electrically and spatially separated from a non-linear magnetic material. In the embodiment shown, the non-linear material is shown as a wire placed as a parasitic element to a dipole antenna of the RFID tag. A preferred embodiment in this case also is to have the non-linear material coated with an electrically conducting material if the electrical resistivity of the non-linear material is too high.

[0032] FIG. 3 shows an elevation sketch of a physical layout for the sketch of FIG. 2. The dipole antenna is connected to a silicon chip containing the tag memory, tag electronics, and tag power supply by wires and 36 and 38. The antenna 28 and the chip 34 are mounted on a dielectric material. The non-linear material is mounted on the opposite side of the dielectric material to the antenna chip. In this embodiment, the non-linear material may once again be coated with a good electrical conductor.

[0033] FIG. 4 shows an alternative arrangement of FIG. 2. The silicon chip, the antenna, and the non-linear material are all mounted on the same side of a supporting structure made of dielectric. In this embodiment the non-linear material may once again preferably be coated with a good electrical conductor.

[0034] FIG. 5 shows perspective sketch of a preferred alternative antenna arrangement for an RFID tag. A silicon chip is electrically attached to an electrically conducting patch antenna. The silicon chip is also electrically attached to an electrically conducting ground plane which is spatially separated from the patch antenna by a dielectric material (not shown). In the embodiment shown in FIG. 5, the electrically conducting ground plane is made from non-linear magnetic material. In this embodiment, the non-linear material may once again preferably be coated with a good electrical conductor.

[0035] FIG. 6 shows a perspective sketch of a patch antenna mounted coplanar with a non-linear magnetic material. The magnetic material may be in the form of a wire or in the form of a sheet as shown in the diagram.

[0036] FIG. 7 shows an elevation sketch of the apparatus of FIG. 5. In this case, the dielectric material supporting the patch antenna, the chip, and the ground plane is explicitly shown. The alternative embodiment having a conducting material coating the non-linear material is also shown. In this case, the material of the patch antenna is alternatively made of a non-linear magnetic material instead of the ground plane. Once again, the non-linear material may once again preferably be coated with a good electrical conductor.

[0037] FIG. 8 shows an elevation sketch of the apparatus of FIG. 6 showing the supporting dielectric material.
We claim as our invention:

1. A system for anti-theft protection and article identification, comprising
   a transponder having an anti-theft portion for signaling the status of the article; and
   an article identification portion for providing coded article information.

2. The system of claim 1, wherein the article identification portion is associated with an article, and communicates with a database to provide information concerning the identity of the article.

3. The system of claim 1, wherein the anti-theft portion communicates information indicating whether or not a given article has been paid for.

4. The system of claim 1, further comprising an interrogator for interrogating the transponder to obtain status and article identification information.

5. The method of monitoring the movement of items, which comprises
   associating a transponder with each of the items which transponder is operative to supply status and identity information for the associated item in response to interrogation thereof; and
   interrogating the transponder to obtain both status and identity information therefrom for the associated item.

6. The method of claim 5, wherein the status information indicates whether or not a given item has been paid for, so that the identity information is available to identify the frequency of attempted theft for a given item.

7. The method of claim 5, wherein the interrogating step comprises applying a radio frequency field to the transponder.

8. The method of claim 7, wherein the transponder has a circuit which is generally resonant at the frequency of the radio frequency field.

9. The method of claim 7, further comprising applying an auxiliary field to the transponder.

10. The method of claim 9, wherein the auxiliary field is a magnetic field.

11. The method of claim 9, wherein the auxiliary field is an electromagnetic field.

12. A transponder comprising:
   an anti-theft portion; and
   an article identification portion.

13. The transponder of claim 12, wherein the article identification portion is associated with an article, and communicates with a database to provide information concerning the identity of the article.

14. The transponder of claim 12, wherein the anti-theft portion supplies status information in response to an interrogating field.

15. The transponder of claim 12, wherein the transponder is subjected to a radio frequency field.

16. The transponder of claim 15, wherein the transponder has a circuit which is generally resonant at the frequency of the radio frequency field.

17. The transponder of claim 15, wherein the transponder is further subjected to an auxiliary field.

18. The transponder of claim 15, wherein the transponder is further subjected to a magnetic field.

19. The transponder of claim 15, wherein the transponder is further subjected to an electromagnetic field.

20. The transponder of claim 15, wherein the transponder is further subjected to an acoustic energy field.

* * * * *