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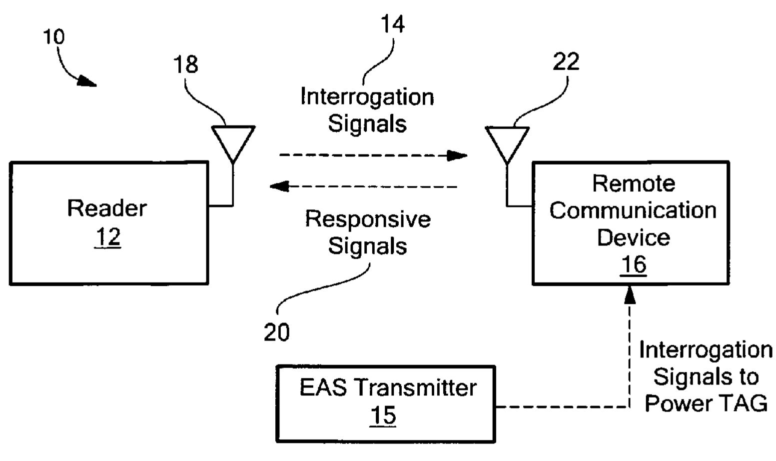

FIG. 1

(57) Abstract: A method and system for increasing the read range of a security tag by supplying an additional antenna system to the tag in order to provide power to a radio frequency identification ("RPID") chip without the need to rely solely on power from the RFID reader. The security tag includes an RFID chip and a first antenna circuit coupled to the RFID chip where the first antenna circuit is adapted to decode interrogation signals from an RFID reader. The security tag also includes a second antenna circuit coupled to the RFID chip. The second antenna circuit is adapted to induce power from signals received from at least an alternate power source, such as an EAS transmitter, so that the RFID chip can be powered up and activated during an RFID interrogation round.

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METHOD AND SYSTEM FOR ITEM LEVEL UHF RFID TAG WITH LOW FREQUENCY POWER ASSIST

FIELD OF THE INVENTION

The present invention generally relates to electronic security systems, and in particular to a method and system for increasing the read range of a radio frequency identification ("RFID") tag by supplying an additional electronic article surveillance ("EAS") antenna system to the RFID tag in order to provide power to the RFID device in the RFID tag.

BACKGROUND OF THE INVENTION

Item interrogation systems are common in the art. One type of item interrogation system is an RFID system. RFID systems are used in many different applications, including for example in retail environments, to obtain information relating to items tagged with RFID identifiers. For example, an RFID tag can be attached or integrated within a product or product packaging. Using an RFID interrogator (also referred to herein as an "RFID reader"), which may be a fixed, portable or handheld device, RFID tags within the interrogation zone of the interrogator may be activated and provide information regarding the item associated with the RFID tag (e.g., product descriptor, serial number, location, etc.).

These RFID tags receive and respond to radio frequency ("RF") signals to provide information, for example, related to the product to which the RFID tag is attached. This is typically accomplished using a standard air interface protocol such as the Electronic Product Code ("EPC") Radio Frequency Identity Protocol. Such information may include inventory information relating to items on a shelf or items in a warehouse. In general, modulators within the RFID tags may transmit back a signal using a transmitter or reflect back a signal to the RFID readers. This transmitted/reflected signal is referred to as a backscatter signal. Additionally, information may be communicated to the RFID tags (e.g., encoding information) using RFID encoders. Thus, RFID systems are typically used to monitor the inventory of products in a retail environment and provide product identification using the storage and remote retrieval of data using RFID tags or transponders.

Typical item interrogation systems provide one or more item level Ultra High Frequency ("UHF") tags, which receive interrogation signals from the interrogation unit, i.e. the RFID reader. The interrogation unit can also supply power signals in order to power up and activate the tags. However, due to their small antenna size, the tags may not always be able to absorb enough power from the interrogation unit to be powered up and activated. If the power being absorbed from the interrogation unit is not sufficient, the tag cannot participate in an RFID inventory round.

Electronic article surveillance ("EAS") systems are detection systems that allow the identification of a marker or tag within a given detection zone. EAS systems have many uses, but most often they are used as security systems for preventing shoplifting in stores or removal of property in office buildings. EAS systems come in many different forms and make use of a number of different technologies. For example, a typical acousto-magnetic EAS system includes an electronic detection unit, tags and/or markers, and a detacher or deactivator. The detection units can, for example, be formed as pedestal units, buried under floors, mounted on walls, or hung from ceilings. The detection units are usually placed in high traffic areas, such as entrances and exits of stores or office buildings. In operation, the EAS unit transmits a detection signal at a predetermined, e.g., 58kHz, frequency. An activated EAS tag resonates at approximately a corresponding frequency. The EAS detector can detect this resonant signal within the EAS detection zone, to thereby determine than an active EAS tag is present. While it is becoming more and more common to implement combination tags that include EAS, e.g., acousto-magnetic and RFID elements, the underlying RFID and EAS systems, and the resultant tags, are not integrated to the point where aspects of one system can be used to provide a benefit to the other system. For example, a system does not currently exist that that allow the range of RFID tag activation and reading to be extended by providing a supplemental means for passive RFID chip power.

Therefore, what is needed is a supplemental antenna system that would provide a source of power to the tags and the RFID chip, thus obviating the need for the tags to rely solely on the RFID reader for its source of power.

SUMMARY

An aspect of the present disclosure provides a method and system for increasing the read range of a radio frequency identification ("RFID") tag by supplying an additional antenna system in order to provide power to the RFID device within the tag, where the power is received from an electronic article surveillance ("EAS") system. In one aspect of the disclosure, a security tag is provided. The tag includes a radio frequency identification ("RFID") device, a first antenna circuit coupled to the RFID device, where the first antenna circuit is adapted to decode interrogation signals from an RFID reader, and a second antenna circuit coupled to the RFID device. The second antenna circuit is adapted to induce power from signals received from at least an alternate power source.

In another aspect, a combination RFID/EAS system is provided. The system includes an RFID reader generating RFID interrogation signals and an EAS transmitter generating EAS interrogation signals. The system also includes a security tag arranged to receive the EAS and RFID interrogation signals and transmit a response signal. The security tag includes an RFID device, a first antenna circuit coupled to the RFID device where the first antenna circuit is adapted to decode interrogation signals from an RFID reader, and a second antenna circuit coupled to the RFID device. The second antenna circuit is adapted to induce energy from signals received from at least the EAS transmitter.

In yet another aspect of the disclosure, a method of powering a security tag is provided. The security tag receives interrogation signals from an RFID device. The method includes receiving an RFID signal from the RFID device, receiving a transmission signal from an alternate device, and inducing energy from the received transmission signal, where the induced energy allows the security tag to be activated and to participate in an RFID inventory round with the RFID device.

According to an aspect of the present disclosure, there is provided a combination Radio Frequency Identification ("RFID")/Electronic Article Surveillance ("EAS") security tag comprising: an RFID device; an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to an RFID interrogation signal; and a resonant EAS antenna circuit coupled to the RFID device, the resonant antenna circuit including one of an air coil and ferrite core coil, the resonant EAS antenna circuit configured to: receive at least one signal at a predetermined frequency, the at least one signal at the predetermined frequency including an

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EAS interrogation signal; resonate a response signal at a detectable level when introduced to the at least one signal at the predetermined frequency; and provide power to the RFID device based at least in part on the received at least one signal at the predetermined frequency.

According to an aspect of the present disclosure, there is provided a combination radio frequency identification ("RFID")/electronic article surveillance ("EAS") system, the system comprising: an RFID reader generating an RFID interrogation signal; an EAS transmitter forming an EAS interrogation signal at a predetermined frequency; and a security tag arranged to receive the EAS and RFID interrogation signals, the security tag comprising: radio frequency identification ("RFID") device; an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to the RFID interrogation signal; and a resonant EAS antenna circuit coupled to the RFID device, the resonant antenna circuit including one of an air coil and ferrite core coil, the resonant EAS antenna circuit configured to: receive at least one signal at the predetermined frequency, the at least one signal at the predetermined frequency including the EAS interrogation signal; provide power to the RFID device based at least in part on the received at least one signal; and resonate a response signal at a detectable level when introduced to the at least one signal at the predetermined frequency.

According to an aspect of the present disclosure, there is provided a method of powering a security tag, the security tag receiving interrogation signals from a radio frequency identification ("RFID") reader, the method comprising: providing power to an RFID device when introduced to an RFID interrogation signal; providing power to the RFID device when a resonant Electronic Article Surveillance ("EAS") antenna circuit in the security tag is introduced to at least one signal at a predetermined frequency to allow the security tag

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to be activated and participate in an RFID inventory round with the RFID reader, the at least one signal including an EAS interrogation signal, the RFID interrogation signal being different from the at least one signal at the predetermined frequency; and resonating a response signal, from the resonant EAS antenna circuit including one of an air coil and ferrite core coil, at a detectable level when introduced to the at least one signal at the predetermined frequency.

According to an aspect of the present disclosure, there is provided a combination Radio Frequency Identification ("RFID")/Electronic Article Surveillance ("EAS") security tag comprising: an RFID device; an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to an RFID interrogation signal; a resonant EAS antenna circuit coupled to the RFID device, the resonant EAS antenna circuit configured to: receive at least one signal at a predetermined frequency, the at least one signal at the predetermined frequency including an EAS interrogation signal; resonate a response signal at a detectable level when introduced to the at least one signal at a predetermined frequency; and provide power to the RFID device based at least in part on the received at least one signal at the predetermined frequency; and the power being provided by the resonant EAS antenna circuit allows the security tag to be activated and participate in an RFID inventory round with the RFID reader, the resonant EAS antenna circuit providing power to the RFID circuit in addition to the power provided by the RFID antenna circuit; and the security tag is configured to only participate in the RFID inventory round if power is provided via the resonant EAS antenna circuit.

According to an aspect of the present disclosure, there is provided a combination radio frequency identification ("RFID")/electronic article surveillance ("EAS") system, the system comprising: an RFID reader generating an RFID interrogation signal; an EAS transmitter forming an EAS interrogation signal at a predetermined frequency; a security tag arranged to receive the EAS and RFID interrogation signals, the security tag comprising: a radio frequency identification ("RFID") device; an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to the RFID interrogation signal; and a resonant EAS antenna circuit coupled to the RFID device, the resonant EAS antenna circuit configured to: receive at least one signal at the predetermined frequency, the at least one signal at the predetermined frequency including the EAS interrogation signal; and provide power to the RFID device based at least in part on the received at least one signal; and resonate a response

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signal at a detectable level when introduced to the at least one signal at the predetermined frequency; the power provided by the resonant EAS antenna circuit of the security tag allowing the security tag to be activated and participate in an RFID inventory round with the RFID reader; and the security tag is configured to only participate in the RFID inventory round if power is provided via the resonant EAS antenna circuit.

According to an aspect of the present disclosure, there is provided a security tag comprising: a radio frequency identification ("RFID") device; a first antenna circuit coupled to the RFID device, the first antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to an RFID interrogation signal from an RFID reader; and a resonant antenna circuit coupled to the RFID device, the resonant antenna circuit including one of an air coil and ferrite core coil, the resonant antenna circuit configured to: resonate at a detectable level when introduced to a signal at predetermined frequency; and provide power to the RFID device.

Additional aspects of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The aspects of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention, and the attendant advantages and features thereof, will be more readily understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a block diagram of an exemplary surveillance system constructed in accordance with the principles of the present invention;

FIG. 2 is a block diagram of the dual-antenna design of an RFID tag constructed in accordance with the principles of the present invention;

FIG. 3 is a block diagram of an EAS pedestal system constructed in accordance with the principles of the present invention; and

FIG. 4 is a block diagram of an RFID shelf reader system constructed in accordance with the principles of the present invention

DETAILED DESCRIPTION OF THE INVENTION

Before describing in detail exemplary embodiments that are in accordance with the present invention, it is noted that the embodiments reside primarily in combinations of apparatus components and processing steps related to implementing a system and method for powering radio frequency identification ("RFID") tags via the use of an additional antenna circuit such that the RFID tag does not rely solely on the RFID reader for its activation power. Accordingly, the system and method components have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

As used herein, relational terms, such as "first" and "second," "top" and "bottom," and the like, may be used solely to distinguish one entity or element from another entity or element without necessarily requiring or implying any physical or logical relationship or order between such entities or elements.

One embodiment of the present invention advantageously provides a method and system for providing an additional antenna system responsive to signals from an electronic article surveillance ("EAS") with the purpose of providing power to the RFID chip resulting in the extension of the read range of the RFID tag. Referring now to the drawing figures in which like reference designators refer to like elements there is shown in FIG. 1 a surveillance system constructed in accordance with the principles of the present invention and designated generally as "10". System 10 represents a surveillance system that may include both the theft prevention features of an Electronic Article Surveillance (EAS) security system with the item identification features of a Radio Frequency Identification (RFID) identification system. It should be noted that the present invention is not limited in use to a particular type of EAS system and can be used in various types of EAS systems, such as for example a 58 KHz AM EAS system, or a Swept RF EAS system.

System 10 has the capability of alerting staff employees of a potential theft while the customer is still inside the store. Combining EAS technology with RFID technology can potentially provide manufacturers great benefit since they can use RFID to track inventory through the supply chain and use EAS to secure items on the retail floor.

Referring again to FIG. 1, reader 12 could be in the form of, for example, a reader unit used to transmit interrogation signals 14 to a remote communication device, i.e., tag 16. Reader 12 can be an RFID reader or a combination EAS/RFID reader that can include a radio frequency module (transmitter and receiver), a control unit, a coupling element to the tags, and a power supply. Additionally, many readers are equipped with interface hardware to enable transmission of data received from the tags to another system, e.g., PC, automatic control systems, etc.

Reader 12 includes antenna 18, which emits radio signals to activate the tag 16 and read and/or write data to it. Antenna 18 provides the conduit between the tag 16 and the reader 12, which controls the system's data acquisition and communication. The electromagnetic field produced by antenna 18 is constantly present if multiple tags are continually passing through the interrogation zone. If constant interrogation is not an application requirement, then a sensing device can activate the electromagnetic field thereby conserving power.

Tag 16 is an electronic transmitter/responder, typically placed on or embedded within an object, representing the actual data-carrying device of an RFID interrogation system. Tag 16 responds to a transmitted or communicated request signal 14 for its encoded data from an RFID interrogator, i.e., reader 12. Tags 16 emit wireless signals over an open air interface using radio frequency waves to communicate with one another.

Tags 16 include an active or passive RFID component. Tags 16 may optionally include an EAS element such as an acousto-magnetic ("AM") component.

The reader 12 emits radio waves in an interrogation range, the range varying depending upon the power output and the frequency used. As a tag 16 enters and passes through the electromagnetic zone, it senses the reader's activation signal. Reader 12 then decodes the encoded data within the tag's integrated circuit (IC) and passes the data to a host computer for processing.

Typically, the antenna 18 is packaged with the transceiver and decoder in reader 12. Reader 12 can be a hand-held device or in a fixed-position/fixed-mount configuration depending upon the desired application. Antenna 18 is capable of transmitting EAS and/or RFID interrogation signals 14 to tag 16 and is also capable of receiving responsive communication signals 20 from tag 16. Tag 16 typically includes an RFID antenna 22, which absorbs the power from the reader's RFID transmit signal. However, in order to provide additional power to tag 16 to enable it to operate without sole dependence upon reader 12 for its operational power, the present invention advantageously provides an additional antenna system that allows the RFID read range of tag 16 to be expanded. System 10 also includes EAS transmitter 15 that transmits interrogation signals to tag 16. As discussed in greater detail below, EAS transmitter 15 such as the type often embedded in EAS floor pedestals, can provide power, via EAS interrogation signals, to activate tag 16 when power from reader 12 may not otherwise be sufficient to do so.

FIG. 2 illustrates a tag 16 constructed in accordance with the principles of the present invention. Tag 16 includes RFID chip 24, UHF antenna circuit 22 and additional low frequency antenna circuit 26. While UHF antenna circuit 22 operates to decode the RFID interrogation signals 14 from reader 12, low frequency antenna circuit 26 serves to harvest energy from other power sources such as EAS pedestals and EAS transmit antennas embedded in, for example, shelf reader systems. Low frequency antenna circuit 26 is inductively coupled to the transmitter of tag 16 and operates in the near field read region.

In one embodiment, antenna circuit 26 resonates at a low frequency, such as 58KHz. For example, circuit 26 may include a resonant RLC circuit implemented as an air or ferrite core coil with a capacitor, as shown in FIG. 2. A 58 KHz EAS system could detect the tag's resonant RLC circuit and identify it as a normal anti-theft EAS target. The EAS system works in cooperation with UHF RFID reader 12 to provide energy to tag 16 at or near 58 KHz during an RFID inventory round of communications between reader 12 and tag 16. The additional power provided to tag 16 in this fashion allows tag 16 to power up and participate in the UHF inventory round, without relying only on the RFID reader 12 to supply the necessary power. Thus, an EAS detection system can provide not only detection of assets but the additional capability of collecting RFID data from these assets with enhanced RFID read performance. This same enhanced detection could apply to EAS systems that operate at other frequencies.

An example of an implementation of an RFID tag 16 using low frequency antenna circuit 26 is illustrated in FIG. 3. FIG. 3 represents the layout of a 58 KHz pulsed EAS pedestal system with RFID reader 12, multiple tags 16, and a pair of EAS pedestals. Tag 16 is designed as a passive device which utilizes an EAS pedestal system to harvest power not only from the RFID reader 12 but also from the field emitted by a conventional 58 kHz EAS pedestal system. Because only certain tags 16 can detect and be powered by reader 12, the present invention provides a dual power scheme by allowing low frequency antenna circuit 26 within each tag to resonate at a given frequency. This provides an advantage over conventional passive UHF RFID tags that use only the incident energy from reader 12 to power the passive RFID circuitry in the RFID chip 24.

The present invention provides the ability to reliably read an RFID tag 16 as it passes through the EAS pedestals 28, without reading item level tags located near the exit pedestals. Advantageously, the present invention provides an extra tag activation source, the EAS pedestals 28, to assure that only tags 16 between EAS pedestals 28 are powered on and inventoried by RFID reader 12, and solving the problem of reading tags outside the zone between the pedestals that, in prior art systems, has prevented reliable detection and reporting of items leaving a retail store.

In alternate embodiments, the alternate power source is not an EAS transmitter. For example, tag 16 may be powered by a device that transmits signals at a predetermined frequency. Because low frequency antenna circuit 26 resonates at a predetermined frequency, it can harvest energy from other sources that are transmitting signals at a resonating frequency. Thus, the present invention is not limited to only EAS transmitters as the alternate power source but any power source provided the transmitted signal is at a proper frequency.

FIG. 4 shows an alternate exemplary utilization of the present invention. In this embodiment, an RFID reader 12 is utilized in a shelf-inventory system. Shelves A through D each contain items that are to be interrogated by RFID reader 12. Each item includes a tag 16 attached or otherwise affixed to it. Each shelf includes an EAS transmit antenna 30. The present invention provides the ability to use an alternate power source emitted from a multiplexed system of low frequency (58KHz for example) loop antennas, i.e. EAS transmit antennas 30, arranged in store shelves to power the dual power RFID tags 16 such that only tags 16 "illuminated" by the low frequency power source 30 are powered and therefore visible in an RFID inventory round. Multiplexer ("MUX") 32, powered by EAS transmitter circuit 34 controls each EAS transmit antenna 30. Thus, particular shelves or shelf locations can be selectively energized via MUX 32 and inventoried with greater accuracy, and at lower cost when compared to conventional shelf reader systems.

In order to be powered by alternate source EAS transmit antenna 30, each tag 16 includes a loop antenna circuit 26 that couples with the transmitter field of EAS antenna 30 and produces enough energy to power RFID chip 24 in tag 16. An example of how each RFID chip 24 is powered up by EAS transmit antenna 30 is now provided. Assuming the frequency of the EAS antenna transmit field is 58 kHz, the field strength (H) at the approximate center of the transmit antenna pedestals is 0.1 oersted, and RFID chip 24 requires 5 micro watts ($5x10^{-6}$ watts) to be operational, then a coil designed to be 100 turns wound as a square coil, e.g., 1.5 in. x 1.5 in., will result in a voltage of approximately 0.5 volts produced at the center of EAS pedestal 30. The internal impedance of a coil of this type is typically 20 ohms. The load of RFID chip 24 antenna circuit 26 is designed to match this coil impedance, i.e. the load would be 20 ohms. Thus the power transferred to the load would be approximately 7 mW, which is more than sufficient to power RFID chip 24.

In an exemplary embodiment, the power to RFID chip 24 is provided via the use of a rectifier diode and capacitor circuit or other energy storage device. Because the power transmission system is pulsed, with, in the above example, 58 KHz pulses issued at 90 Hz with a duration of 1.6 ms, tag 16 would need to harvest energy from the transmit field and store enough energy in its energy storage circuit or device to keep RFID chip 24 powered until the next burst from EAS transmit antenna 30. Once powered up, RFID tag 24 will be "awake" and able to communicate with RFID reader 12 in an RFID inventory round.

The present invention can be realized in hardware, software, or a combination of hardware and software. Any kind of computing system, or other apparatus adapted for carrying out the methods described herein, is suited to perform the functions described herein.

A typical combination of hardware and software could be a specialized or general purpose computer system having one or more processing elements and a computer program stored on a storage medium that, when loaded and executed, controls the computer system such that it carries out the methods described herein. The present invention can also be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein, and which, when loaded in a computing system is able to carry out these methods. Storage medium refers to any volatile or non-volatile storage device.

Computer program or application in the present context means any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following a) conversion to another language, code or notation; b) reproduction in a different material form.

In addition, unless mention was made above to the contrary, it should be noted that all of the accompanying drawings are not to scale. Significantly, this invention can be embodied in other specific forms without departing from the spirit or essential attributes thereof, and accordingly, reference should be had to the following claims, rather than to the foregoing specification, as indicating the scope of the invention.

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CLAIMS:

1. A combination Radio Frequency Identification ("RFID")/Electronic Article Surveillance ("EAS") security tag comprising:

an RFID device;

an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to an RFID interrogation signal; and

a resonant EAS antenna circuit coupled to the RFID device, the resonant antenna circuit including one of an air coil and ferrite core coil, the resonant EAS antenna circuit configured

to: receive at least one signal at a predetermined frequency, the at least one signal at the predetermined frequency including an EAS interrogation signal;

resonate a response signal at a detectable level when introduced to the at least one signal at the predetermined frequency; and

provide power to the RFID device based at least in part on the received at least one signal at the predetermined frequency.

2. The security tag of Claim 1, wherein the RFID antenna circuit operates at a higher frequency than the resonant EAS antenna circuit.

3. The security tag of Claim 1, further comprising an EAS element, the EAS element resonating an EAS response signal at the detectable level when introduced to the EAS interrogation signal; and

the power provided to the RFID device by the resonant EAS antenna circuit being based at least in part on the EAS response signal emitted by the resonating EAS element.

4. The security tag of Claim 1, wherein the power provided by the resonant EAS antenna circuit allows the security tag to be activated and participate in an RFID inventory round with the RFID reader, the resonant EAS antenna circuit providing power to the RFID circuit in addition to the power provided by the RFID antenna circuit.

5. The security tag of Claim 1, further including an energy storage element, the energy storage element storing energy induced from at least one of the RFID interrogation signal and the at least one signal at the predetermined frequency and providing power to the security tag.

6. The security tag of Claim 1, wherein the power provided by at least one of the RFID antenna circuit and resonant EAS antenna circuit is greater than energy consumed by the security tag such that the security tag remains powered on between periodic bursts of the at least one signal at the predetermined frequency.

7. The security tag of Claim 3, wherein the EAS element is an acousto-magnetic component; and

the resonant circuit being a registor, inductor and capacitor (RLC) circuit.

8. A combination radio frequency identification

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("RFID")/electronic article surveillance ("EAS") system, the system comprising:

an RFID reader generating an RFID interrogation signal;

an EAS transmitter forming an EAS interrogation signal at a predetermined frequency;

and

a security tag arranged to receive the EAS and RFID interrogation signals, the security tag comprising:

a radio frequency identification **("RFID")** device;

an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to the RFID interrogation signal; and

a resonant EAS antenna circuit coupled to the RFID device, the resonant antenna circuit including one of an air coil and ferrite core coil, the resonant EAS antenna circuit configured to:

receive at least one signal at the predetermined frequency, the at least one signal at the predetermined frequency including the EAS interrogation signal;

provide power to the RFID device based at least in part on the received at least one signal; and

resonate a response signal at a detectable level when introduced to the at least one signal at the predetermined frequency.

9. The system of Claim 8, wherein the RFID antenna circuit operates at a higher frequency than the resonant EAS antenna circuit.

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10. The system of Claim 8, wherein the security tag further includes an EAS element, the EAS element resonating at the detectable level when introduced to the EAS interrogation signal at the predetermined frequency.

11. The system of Claim 10, wherein the EAS element is an acousto-magnetic component; and

the resonant circuit being a resistor, inductor and capacitor (RLC) circuit.

12. The system of Claim 8, wherein the detectable level allows the resonant circuit to be identified as an EAS target device.

13. The system of Claim 8, wherein the power provided by the resonant EAS antenna circuit of the security tag allows the security tag to be activated and participate in an RFID inventory round with the RFID reader.

14. The system of Claim 8, wherein the security tag further includes an energy storage element, the energy storage element storing energy induced from at least one of the RFID interrogation signal and the EAS interrogation signal.

15. The system of Claim 7, wherein the power provided by at least one of the RFID antenna circuit and resonant EAS antenna circuit is greater than energy consumed by the security tag such that the security tag remains powered on between periodic bursts of

the EAS interrogation signal at the predetermined frequency.

16. The system of Claim 7, wherein the resonant EAS antenna circuit provides power to the RFID circuit in addition to the power provided by the RFID antenna circuit.

17. A method of powering a security tag, the security tag receiving interrogation signals from a radio frequency identification ("RFID") reader, the method comprising:

providing power to an RFID device when introduced to an RFID interrogation signal;

providing power to the RFID device when a resonant Electronic Article Surveillance ("EAS") antenna circuit in the security tag is introduced to at least one signal at a predetermined frequency to allow the security tag to be activated and participate in an RFID inventory round with the RFID reader, the at least one signal including an EAS interrogation signal, the RFID interrogation signal being different from the at least one signal at the predetermined frequency; and

resonating a response signal, from the resonant EAS antenna circuit including one of an air coil and ferrite core coil, at a detectable level when introduced to the at least one signal at the predetermined frequency.

18. The method of Claim 17, further comprising storing energy induced from at least one of the RFID interrogation signal and the signal at the predetermined frequency, wherein the stored energy is greater than energy consumed by the security tag such that the security tag remains powered on between receipt of the signal at the

predetermined frequency.

19. A combination Radio Frequency Identification ("RFID")/Electronic Article Surveillance ("EAS") security tag comprising:

an RFID device;

an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to an RFID interrogation signal;

a resonant EAS antenna circuit coupled to the RFID device, the resonant EAS antenna circuit configured to:

receive at least one signal at a predetermined frequency, the at least one signal at the predetermined frequency including an EAS interrogation signal;

resonate a response signal at a detectable level when introduced to the at least one signal at a predetermined frequency; and

provide power to the RFID device based at least in part on the received at least one signal at the predetermined frequency; and

the power being provided by the resonant EAS antenna circuit allows the security tag to be activated and participate in an RFID inventory round with the RFID reader, the resonant EAS antenna circuit providing power to the RFID circuit in addition to the power provided by the RFID antenna circuit; and

the security tag is configured to only participate in the RFID inventory round if power is provided via the resonant EAS antenna circuit.

20. A combination radio frequency identification

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("RFID")/electronic article surveillance ("EAS") system, the system comprising:

an RFID reader generating an RFID interrogation signal;

an EAS transmitter forming an EAS interrogation signal at a predetermined frequency;

a security tag arranged to receive the EAS and RFID interrogation signals, the security tag comprising:

a radio frequency identification ("RFID") device;

an RFID antenna circuit coupled to the RFID device, the RFID antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to the RFID interrogation signal; and

a resonant EAS antenna circuit coupled to the RFID device, the resonant EAS antenna circuit configured to:

receive at least one signal at the predetermined frequency, the at least one signal at the predetermined frequency including the EAS interrogation signal; and

provide power to the RFID device based at least in part on the received at least one signal; and

resonate a response signal at a detectable level when introduced to the at least one signal at the predetermined frequency;

the power provided by the resonant EAS antenna circuit of the security tag allowing the security tag to be activated and participate in an RFID inventory round with the RFID reader; and

the security tag is configured to only participate in the RFID inventory round if power is provided via the resonant EAS antenna circuit.

21. A security tag comprising:

a radio frequency identification ("RFID") device;

a first antenna circuit coupled to the RFID device, the first antenna circuit configured to transmit and receive data and provide power to the RFID device when introduced to an RFID interrogation signal from an RFID reader; and

a resonant antenna circuit coupled to the RFID device, the resonant antenna circuit including one of an air coil and ferrite core coil, the resonant antenna circuit configured to:

resonate at a detectable level when introduced to a signal at predetermined frequency; and

provide power to the RFID device.

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Patent Attorneys for the Applicant
SPRUSON & FERGUSON

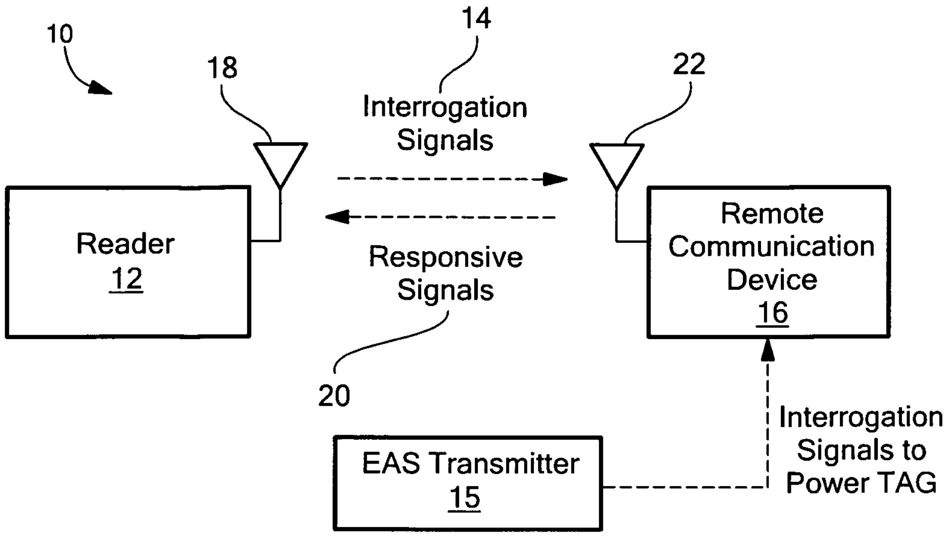
10
18
14
Interrogation Signals
22
Reader 12
Remote Communication Device 16
Responsive Signals
20
EAS Transmitter 15
Interrogation Signals to Power TAG

FIG. 1

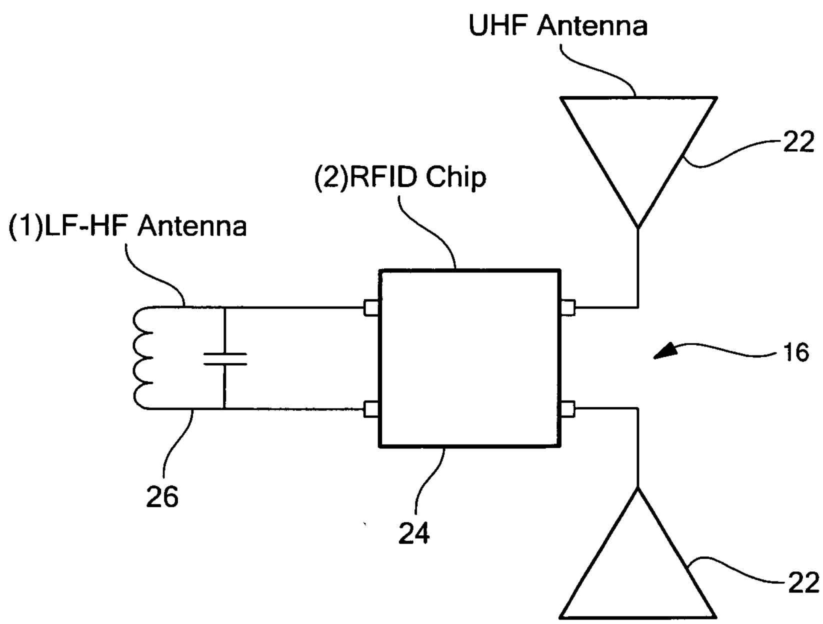
UHF Antenna
22
(2)RFID Chip
(1)LF-HF Antenna
16
26
24
22

FIG. 2

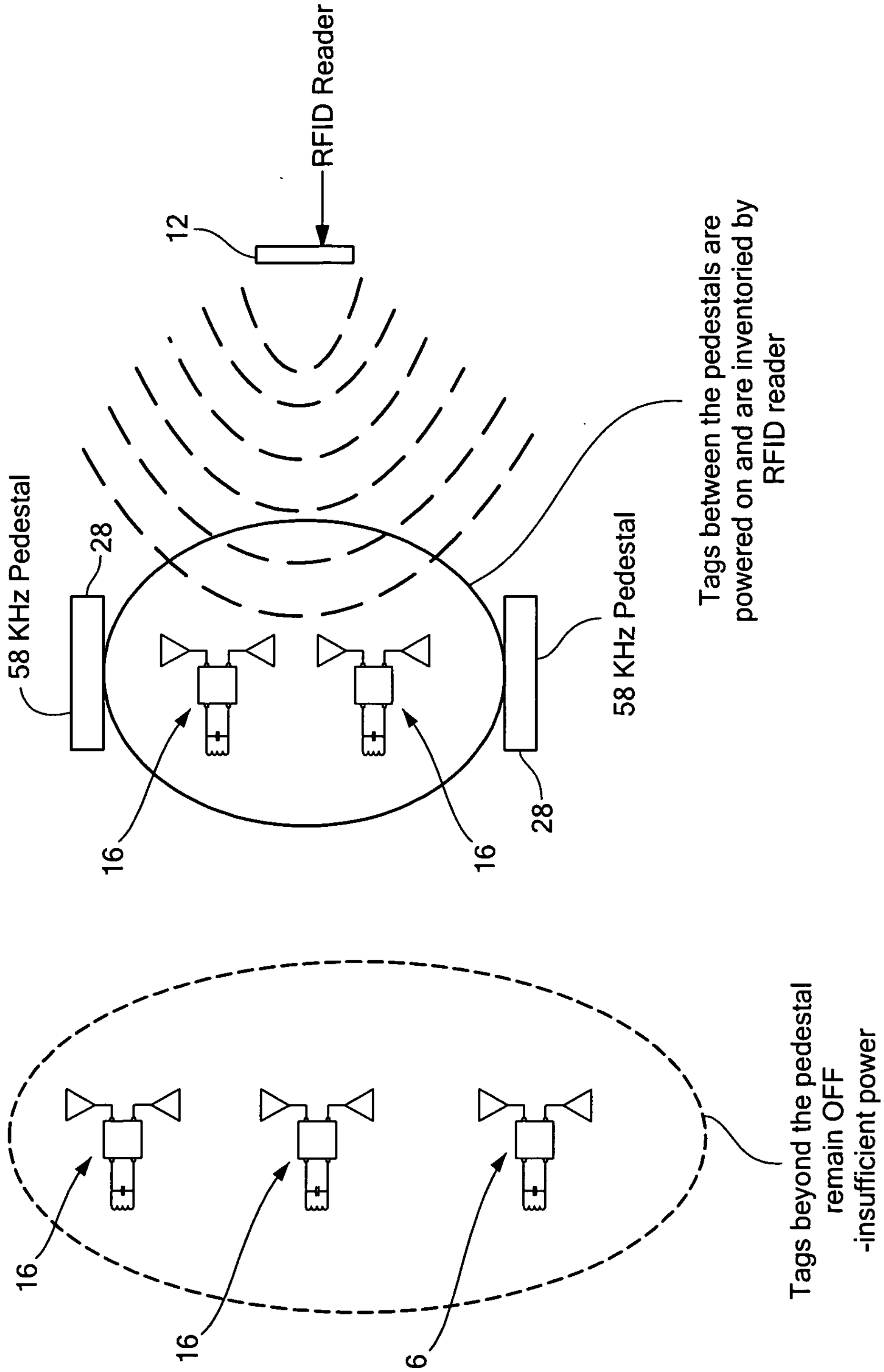
RFID Reader
12
58 KHz Pedestal
28
Tags between the pedestals are powered on and are inventoried by RFID reader
58 KHz Pedestal
28
16
16
Tags beyond the pedestal remain OFF -insufficient power
16
16
16

FIG. 3

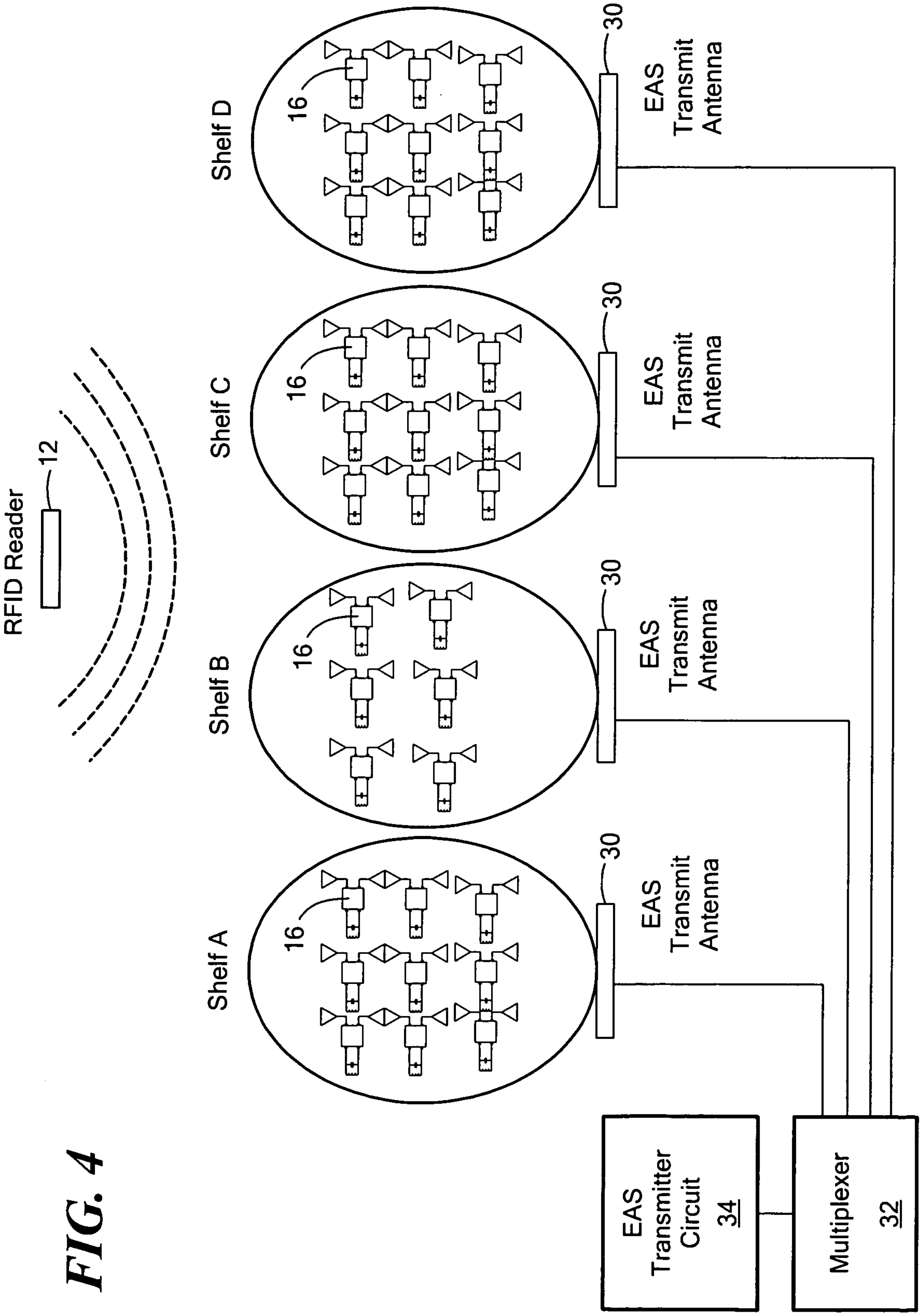
RFID Reader
12
Shelf A
Shelf B
Shelf C
Shelf D
16
30
EAS Transmit Antenna
EAS Transmitter Circuit 34
Multiplexer 32

FIG. 4