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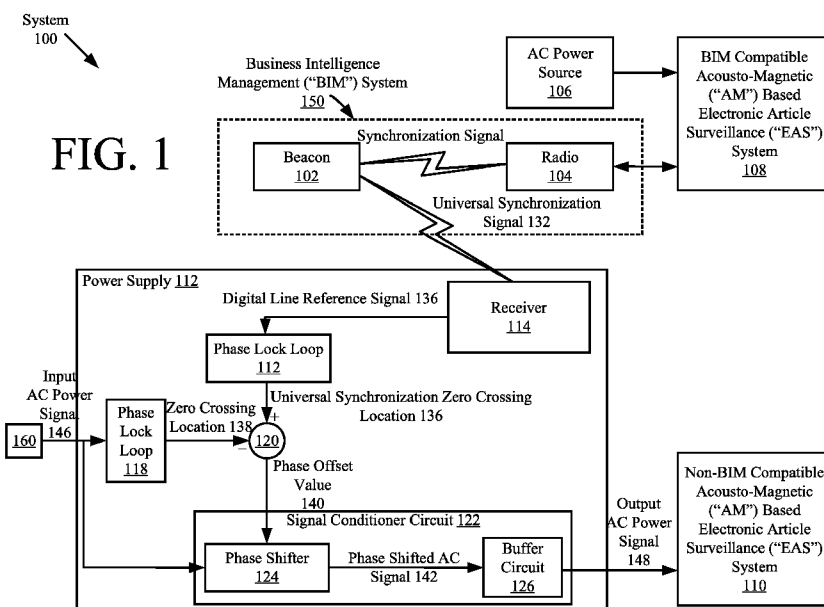
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(54) Title: POWER SUPPLY WITH WIRELESSLY SUPPORTED PHASE OFFSET CONTROL FOR ACOUSTO-MAGNETIC SYSTEMS



(57) **Abstract:** Systems and methods for synchronizing operations of incompatible systems. The methods comprise: programming receiver operations of a Power Supply ("PS") so that PS is interoperable with a first system of the incompatible systems; receiving by PS a wireless universal synchronization signal from a beacon of the first system; determining, by PS, a value for a phase offset setting of an internal signal conditioner circuit based on information contained in the wireless universal synchronization signal; generating a phase shifted Alternating Current ("AC") signal by applying a phase offset to an input AC power signal in accordance with the determined value for the phase offset setting; buffering the phase shifted AC signal to generate an output AC power signal; and using a zero crossing of the output AC power signal to synchronize transmit and receive operations of a second system of the incompatible systems with the first system's transmit and receive operations.



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POWER SUPPLY WITH WIRELESSLY SUPPORTED PHASE OFFSET CONTROL FOR ACOUSTO-MAGNETIC SYSTEMS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application Serial No. 62/699,508 entitled “POWER SUPPLY WITH WIRELESSLY SUPPORTED PHASE OFFSET CONTROL FOR ACOUSTO-MAGNETIC SYSTEMS” and filed on July 17, 2018 the contents of which is incorporated herewith in its entirety.

BACKGROUND

Statement of the Technical Field

[0002] The present disclosure relates generally to acousto-magnetic systems. More particularly, the present disclosure relates to a power supply with wirelessly supported phase offset control for acousto-magnetic systems.

Description of the Related Art

[0003] Electronic Article Surveillance (“EAS”) systems are often used by retail stores in order to minimize loss due to theft. One common way to minimize retail theft is to attach a security tag to an article such that an unauthorized removal of the article can be detected. In some scenarios, a visual or audible alarm is generated based on such detection. For example, a security tag with an EAS element (e.g., an Acousto-Magnetic (“AM”) element) can be attached to an article offered for sale by a retail store. An EAS interrogation signal is transmitted at the entrance and/or exit of the retail store. The EAS interrogation signal causes the EAS element of the security tag to produce a detectable response if an attempt is made to remove the article without first detaching the security tag therefrom. The security tag must be detached from the article upon purchase thereof in order to prevent the visual or audible alarm from being generated.

[0004] Some AM based EAS systems use an AC power line for a synchronization reference. These EAS systems require that all surrounding systems (A) operate from the same

synchronization reference or (B) have appropriate offsets to align transmit and receive functions. Without synchronization, poor performance and/or unwanted alarms affect the same systems which results in considerable frustration to customers, poor Return On Investment (“ROI”), and high service costs due to repeated technician visits.

[0005] To resolve these situations, close coordination and significant efforts are required between competing manufacturers of EAS equipment and service providers to synchronize their systems. These environments often require repeated interventions due to changes in the device landscape.

SUMMARY

[0006] The present disclosure concerns systems and methods for synchronizing operations of incompatible systems. The methods comprise: programming receiver operations of a power supply so that the power supply is interoperable with a first system of the incompatible systems; receiving by the power supply a wireless universal synchronization signal from a beacon of the first system; determining, by the power supply, a value for a phase offset setting of an internal signal conditioner circuit based on information contained in the wireless universal synchronization signal; generating a phase shifted Alternating Current (“AC”) signal by applying a phase offset to an input AC power signal in accordance with the determined value for the phase offset setting; buffering the phase shifted AC signal to generate an output AC power signal; and using a zero crossing of the output AC power signal to synchronize transmit and receive operations of a second system of the incompatible systems with the first system’s transmit and receive operations.

[0007] In some scenarios, the first system comprises a Business Intelligence Management (“BIM”) compatible system and the second system comprises a non-BIM compatible system. Additionally or alternatively, the incompatible systems comprise Acousto-Magnetic (“AM”) based Electronic Article Surveillance (“EAS”) systems. The AM based EAS systems comprise EAS tag detection systems and/or EAS tag deactivation systems.

[0008] In those or other scenarios, the value for a phase offset setting is determined by: generating a digital line reference signal using the information contained in the wireless universal synchronization signal; processing the digital line reference signal by a first Phase Lock Loop (“PLL”) to determine a first zero crossing location; processing the input AC power signal by a second PLL to determine a location of a second zero crossing location; and determining a difference between the first and second zero crossing locations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present solution will be described with reference to the following drawing figures, in which like numerals represent like items throughout the figures.

[0010] FIG. 1 is an illustration of an illustrative system.

[0011] FIG. 2 is a side view of an illustrative EAS tag detection system.

[0012] FIG. 3 is a top view of the EAS tag detection system in FIG. 2, which is useful for understanding an EAS detection zone thereof.

[0013] FIGS. 4 and 5 are drawings which are useful for understanding a main field and a back-field of antennas which are used in the EAS tag detection system of FIG. 2.

[0014] FIG. 6 is a drawing which is useful for understanding a detection zone in the EAS tag detection system of FIG. 2.

[0015] FIG. 7 is a flow diagram of an illustrative method for synchronizing operations of incompatible systems.

[0016] FIG. 8 provides a graph showing illustrative AC power signals.

[0017] FIG. 9 provides graphs showing transmit and receive cycles of AM based EAS systems.

DETAILED DESCRIPTION

[0018] It will be readily understood that the components of the embodiments as generally described herein and illustrated in the appended figures could be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of various embodiments, as represented in the figures, is not intended to limit the scope of the present disclosure, but is merely representative of various embodiments. While the various aspects of the embodiments are presented in drawings, the drawings are not necessarily drawn to scale unless specifically indicated.

[0019] The present solution may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the present solution is, therefore, indicated by the appended claims rather than by this detailed description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

[0020] Reference throughout this specification to features, advantages, or similar language does not imply that all of the features and advantages that may be realized with the present solution should be or are in any single embodiment of the present solution. Rather, language referring to the features and advantages is understood to mean that a specific feature, advantage, or characteristic described in connection with an embodiment is included in at least one embodiment of the present solution. Thus, discussions of the features and advantages, and similar language, throughout the specification may, but do not necessarily, refer to the same embodiment.

[0021] Furthermore, the described features, advantages and characteristics of the present solution may be combined in any suitable manner in one or more embodiments. One skilled in the relevant art will recognize, in light of the description herein, that the present solution can be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages may be recognized in certain embodiments that may not be present in all embodiments of the present solution.

[0022] Reference throughout this specification to “one embodiment”, “an embodiment”, or similar language means that a particular feature, structure, or characteristic described in connection with the indicated embodiment is included in at least one embodiment of the present solution. Thus, the phrases “in one embodiment”, “in an embodiment”, and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

[0023] As used in this document, the singular form “a”, “an”, and “the” include plural references unless the context clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art. As used in this document, the term “comprising” means “including, but not limited to”.

[0024] One conventional solution synchronizes AM based EAS systems using a beacon. The beacon broadcasts a wireless synchronization signal to end nodes which are connected to AM based EAS devices. The end nodes require direct programming through proprietary software interfaces to allow them to communicate with the beacon.

[0025] Currently, there is no method to automatically and continually synchronize other manufacturers’ systems. To integrate other manufacturers’ devices to the above described conventional solution would require considerable design effort and cooperation between manufacturers of AM based EAS systems. Such cooperation requires unique interfaces. Efforts for each manufacturer would also need to be integrated. This would potentially expose closely held trade knowledge and device data.

[0026] The present solution addresses these challenges between manufacturers’ AM systems. The present solution allows for adjusting the phase offset (synchronization) reference of an AM based EAS system that uses an AC power line signal as its reference signal, without a need to integrate anything into the product. The benefits are: a universal design reference for all devices; eliminates the need to integrate to each manufacturer’s proprietary design saving considerable development costs; removes challenges; provides a permanent synchronization solution that automatically synchronizes non-Business Intelligence Module (“BIM”) compatible systems to a BIM system. The present solution uses the wireless synchronization beacon from the BIM

system or other beacon to adjust a Phase Lock Loop (“PLL”) controlled power supply. The power supply has external controls to configure the power supply to a Personal Area Network (“PAN”) identifier (“ID”) of the controlling BIM beacon or other beacon. The present solution uses this signal to offset the phase of the AC power output from the power supply. This offset has the effect of delaying (or advancing) the synchronization trigger for the attached non-BIM compatible AM based EAS device, in turn adjusting the offset for transmit and receive cycles, to synchronize them with adjacent synchronization controlled BIM compatible AM systems.

[0027] The present solution has multiple operating modes: a controlled mode; a fixed mode; and an autonomous mode. In the control mode, the direct wireless control of a phase offset from a master beacon is allowed by programming of a novel power supply. The novel power supply is designed to support a programmable user interface and/or external manual controls for toolless programming. In the fixed mode, the manual adjustment and setting of the phase offset is allowed through the power supply external manual controls. In the autonomous mode, the power supply is able to find and come under control of its phase offset when a master beacon’s signal is detected.

[0028] In view of the forgoing, the present solution concerns systems and methods for synchronizing operations of incompatible systems. The methods comprise: programming receiver operations of a power supply so that the power supply is interoperable with a first system of the incompatible systems; receiving by the power supply a wireless universal synchronization signal from a beacon of the first system; determining, by the power supply, a value for a phase offset setting of an internal signal conditioner circuit based on information contained in the wireless universal synchronization signal; generating a phase shifted AC signal by applying a phase offset to an input AC power signal in accordance with the determined value for the phase offset setting; buffering the phase shifted AC signal to generate an output AC power signal; and using a zero crossing of the output AC power signal to synchronize transmit and receive operations of a second system of the incompatible systems with the first system’s transmit and receive operations.

[0029] In some scenarios, the first system comprises a BIM compatible system and the second system comprises a non-BIM compatible system. Additionally or alternatively, the incompatible systems comprise AM based EAS systems. The AM based EAS systems comprise EAS tag detection systems and/or EAS tag deactivation systems.

[0030] In those or other scenarios, the value for a phase offset setting is determined by: generating a digital line reference signal using the information contained in the wireless universal synchronization signal; processing the digital line reference signal by a first PLL to determine a first zero crossing location; processing the input AC power signal by a second PLL to determine a location of a second zero crossing location; and determining a difference between the first and second zero crossing locations.

[0031] Illustrative System

[0032] Referring now to FIG. 1, there is provided an illustration of a system **100** implementing the present solution. System **100** comprises a Business Intelligence Management (“BIM”) system **150** that is generally configured to enhance efficiency of a business (e.g., a retail store) through inventory intelligence. The inventory intelligence is achieved using a beacon **102** and a radio **104** (A) to collect information about EAS tags from a BIM compatible AM based EAS system **108** and (B) to control operations of the BIM compatible AM based EAS system **108** (e.g., transmit and receive timing). Beacons and radios are well known in the art, and therefore will not be described in detail herein. In some scenarios, the beacon **102** comprises a BIM1000 beacon available from Tyco International GmbH of Boca Raton Florida, and the radio is a BIX1000 radio also available from Tyco International GmbH of Boca Raton Florida.

[0033] The BIM compatible AM based EAS system **108** includes, but is not limited to, an EAS tag detection system and/or an EAS tag deactivation system (e.g., a tag deactivator unit located at a Point of Sale station). Both of these types of EAS systems are well known in the art, and therefore will not be described herein. Any known or to be known AM based EAS system can be used here provided that it is BIM compatible. The BIM compatible AM based EAS system **108** is supplied power from an AC power source **106**. AC power sources are well known

in the art, and therefore will not be described herein. Any known or to be known AC power source can be used herein without limitation.

[0034] A graph is provided in FIG. 8 that shows an illustrative input AC power signal **800** provided from the AC power source **106** to the AM based EAS system **108**. The transmit and receive cycle timing of the BIM compatible AM based EAS system **108** is controlled by the BIM system **150**. For example, the zero crossing **806** of the input AC power signal **800** is used to control the transmit and receive cycle timing.

[0035] Another AM based EAS system **110** is located near the AM based EAS system **108**. The AM based EAS system **110** also includes, but is not limited to, an EAS tag detection system and/or an EAS tag deactivation system (e.g., a tag deactivator unit located at a Point of Sale station). The AM based EAS system's transmit and receive operations are not typically synchronized with those of the AM based EAS system **108** since the zero crossing of the input AC power signal supplied thereto by another power source **160** is offset from the zero crossing of the AC power signal supplied by the AC power source **106** to the AM based EAS system **108**. This is shown in the graphs of FIG. 8-9. In FIG. 8, the AC power signal **800** represents the AC power signal supplied to the AM based EAS system **108** and AC power signal **802** represents the AC power signal supplied to the AM based EAS system **110**. There is a ninety degrees phase offset **804** between the two signals **800**, **802**. In FIG. 9, graph **900** represents the transmit and receive operations of the BIM compatible AM based EAS system **108** and graph **904** represents the transmit and receive operations of the non-BIM compatible AM based EAS system **110** when the present solution is not being employed. There is an offset **912** between the transmit/receive ("Tx/Rx") cycle **906** of the BIM compatible AM based EAS system **108** and the Tx/Rx cycle **910** of the non-BIM compatible AM based EAS system **110**.

[0036] Since the AM based EAS system **110** is not BIM compatible, its transmit and receive operations are unable to be synchronized with those of the AM based EAS system **108** via the BIM system **150**. Accordingly, a novel power supply **112** is provided to facilitate this synchronization. The novel power supply **112** is disposed between the input AC power source **160** and the non-BIM compatible AM based EAS system **110**.

[0037] The power supply **112** comprises a receiver **114** that is programmed to receive universal synchronization signals **132** from the beacon **102** of the BIM system **150**. Receivers are well known in the art, and therefore will not be described herein. Any known or to be known receiver can be used herein without limitation. Upon receipt of a universal synchronization signal **132**, the receiver **114** generates a digital line reference signal **136** using information contained in the signal **132**. In some scenarios, the universal synchronization signal **132** is packet based, i.e., a packet is periodically transmitted (e.g., every 50-60 Hz). The information included in the packet comprises timing information for transmit and receive operations of a BIM compatible AM based EAS system. The digital line reference signal **136** is provided to a Phase Lock Loop (“PLL”) **112**. PLLs are well known in the art, and therefore will not be described herein. Any known or to be known PLL can be used herein without limitation.

[0038] The PLL **112** processes the digital line reference signal **136** to determine the location of the zero crossing of the AC power signal output from the AC power source **106** (e.g., zero crossing **806** of FIG. 8). The location **136** of this zero crossing is then provided to a subtractor **120**. The subtractor **120** determines a difference between the universal synchronization zero crossing location **136** and a zero crossing location **138** of an input AC power signal **146** (e.g., zero crossing **808** of FIG. 8) output from a PLL **118**. This difference is then output from the subtractor **120** as a phase offset value **140**. Subtractors are well known in the art, and therefore will not be described herein. The phase offset value **140** is used to set a phase offset parameter of a signal conditioner circuit **122**.

[0039] The signal conditioner circuit **122** comprises a phase shifter **124** and a buffer circuit **126**. Phase shifters and buffer circuits are well known in the art, and therefore will not be described in detail herein. Any known or to be known phase shifter and buffer circuit can be used herein without limitation. During operation, the phase shifter **124** receives the input AC power signal **146** from power source **160** and processes the same to shift the phase thereof in accordance with the phase offset value **140**. The phase shifter **124** then supplies the phase shifted AC signal **142** to the buffer circuit **126**. The buffer circuit **126** buffers the phase shifted AC signal **142** to generate an output AC power signal **148**. The output AC power signal **148** is

then provided to the non-BIM compatible AM based EAS system **110**. The output AC power signal **148** is used to synchronize the transmit and receive cycles of the non-BIM compatible AM based EAS system **110** with those of the BIM compatible AM based EAS system **108**. This is shown in FIG. 9. In FIG. 9, graph **900** shows the transmit and receive cycles **906** of the BIM compatible AM based EAS system **108** and graph **902** shows the transmit and receive cycles **908** of the non-BIM compatible AM based EAS system **110** when the present solution is employed. Notably, the Tx/Rx cycles **906**, **908** of the two systems **108**, **110** are synchronized with each other.

[0040] Referring now to FIGS. 2 and 3, an illustrative architecture for an EAS tag detection system **200** is provided. The AM based EAS system **108** and/or **110** can be the same as or similar to the EAS tag detection system **200**. As such, the discussion of the EAS tag detection system **200** is sufficient for understanding the AM based EAS system **108** and/or **110** of FIG. 1.

[0041] The EAS tag detection system **200** is positioned at a location adjacent to an entry/exit **104** of a secured facility (e.g., a retail store). The EAS tag detection system **200** uses specially designed EAS marker tags (“security tags”) which are applied to store merchandise or other items which are stored within a secured facility. Security tags are well known in the art, and therefore will not be described herein in detail. Any known or to be known security tag can be used herein without limitation. The security tags can be deactivated or removed by authorized personnel at the secure facility. For example, in a retail environment, the security tags could be removed by store employees.

[0042] When an active security tag **212** is detected by the EAS tag detection system **200** in an idealized representation of an EAS detection zone (or interrogation zone) **250** near the entry/exit, the EAS tag detection system will detect the presence of such security tag and will sound an alarm or generate some other suitable EAS response. Accordingly, the EAS tag detection system **200** is arranged for detecting and preventing the unauthorized removal of articles or products from controlled areas.

[0043] The EAS tag detection system **200** includes a pair of pedestals **202a**, **202b**, which are located a known distance apart (e.g., at opposing sides of an entry/exit **204**). The pedestals **202a**,

202b are typically stabilized and supported by a base **206a**, **206b**. The pedestals **202a**, **202b** will each generally include one or more antennas that are suitable for aiding in the detection of the special EAS security tags, as described herein. For example, pedestal **202a** can include at least one antenna **402** suitable for transmitting or producing an electromagnetic exciter signal field (or interrogation signal) and receiving response signals generated by active security tags in the EAS detection zone **250**. In some scenarios, the same antenna can be used for both receive and transmit functions. Similarly, pedestal **202b** can include at least one antenna **402** suitable for transmitting or producing an electromagnetic exciter signal field (or interrogation signal) and receiving response signals generated by security tags in the EAS detection zone **250**. The antennas provided in pedestals **202a**, **202b** can be conventional conductive wire coil or loop designs as are commonly used in AM type EAS pedestals. These antennas will sometimes be referred to herein as exciter coils. In some scenarios, a single antenna can be used in each pedestal. The single antenna is selectively coupled to the EAS receiver. The EAS transmitter is operated in a time multiplexed manner. However, it can be advantageous to include two antennas (or exciter coils) in each pedestal as shown in FIG. 2, with an upper antenna positioned above a lower antenna.

[0044] The antennas located in the pedestals **202a**, **202b** are electrically coupled to a system controller **210**. The system controller **210** controls the operation of the EAS tag detection system **200** to perform EAS functions as described herein. The system controller **210** can be located within a base **206a**, **206b** of one of the pedestals **202a**, **202b** or can be located within a separate chassis at a location nearby to the pedestals. For example, the system controller **210** can be located in a ceiling just above or adjacent to the pedestals **202a**, **202b**.

[0045] As noted above, the EAS detection system comprises an AM type EAS detection system. As such, each antenna is used to generate an Electro-Magnetic (“EM”) field which serves as a security tag exciter signal. The security tag exciter signal (or interrogation signal) causes a mechanical oscillation of a strip (e.g., a strip formed of a magnetostrictive or ferromagnetic amorphous metal) contained in a security tag within an EAS detection zone **250**. As a result of the stimulus signal, the security tag will resonate and mechanically vibrate due to

the effects of magnetostriction. This vibration will continue for a brief time after the stimulus signal (or interrogation signal) is terminated. The vibration of the strip causes variations in its magnetic field, which can induce an AC signal in the receiver antenna. This induced signal is used to indicate a presence of the strip within the EAS detection zone (or interrogation zone)

250. As noted above, the same antenna contained in a pedestal **202a**, **202b** can serve as both the transmit antenna and the receive antenna. Accordingly, the antennas in each of the pedestals **202a**, **202b** can be used in several different modes to detect a security tag exciter signal. These modes will be described below in further detail.

[0046] Referring now to FIGS. 4 and 5, there are shown exemplary antenna field patterns **400**, **500** for antennas **402**, **502** contained in pedestals **202a**, **202b**. As is known in the art, an antenna radiation pattern is a graphical representation of the radiating (or receiving) properties for a given antenna as a function of space. The properties of an antenna are the same in a transmit mode and a receive mode of operation. As such, the antenna radiation pattern shown is applicable for both transmit and receive operations as described herein. The exemplary antenna field patterns **400**, **500** shown in FIGS. 4-5 are azimuth plane patterns representing the antenna pattern in the x, y coordinate plane. The azimuth pattern is represented in polar coordinate form and is sufficient for understanding the inventive arrangements. The azimuth antenna field patterns shown in FIGS. 4-5 are a useful way of visualizing the direction in which the antennas **402**, **502** will transmit and receive signals at a particular transmitter power level.

[0047] The antenna field pattern **400** shown in FIG. 4 includes a main lobe **404** with a peak at $\phi = 0^\circ$ and a back-field lobe **406** with a peak at angle $\phi = 180^\circ$. Conversely, the antenna field pattern **500** shown in FIG. 5 includes a main lobe **504** with its peak at $\phi = 180^\circ$ and a back-field lobe **506** with a peak at angle $\phi = 0^\circ$. In the EAS tag detection system **200**, each pedestal **202a**, **202b** is positioned so that the main lobe of an antenna contained therein is directed into the EAS detection zone (or interrogation zone) **250**. Accordingly, a pair of pedestals **202a**, **202b** in the EAS tag detection system **200** will produce overlap in the antenna field patterns **400**, **500**, as shown in FIG. 6. Notably, the antenna field patterns **400**, **500** shown in FIG. 6 are scaled for purposes of understanding the present solution. In particular, the patterns show the outer

boundary or limits of an area in which an exciter signal of particular amplitude applied to antennas **402**, **502** will produce a detectable response in an EAS security tag. However, it should be understood that a security tag within the bounds of at least one antenna field pattern **400**, **500** will generate a detectable response when stimulated by an exciter signal.

[0048] The overlapping antenna field patterns **400**, **500** in FIG. 6 will include an area **A** where there is overlap of main lobes **404**, **504**. However, it can be observed in FIG. 6 that there can also be some overlap of a main lobe of each pedestal with a back-field lobe associated with the other pedestal. For example, it can be observed that the main lobe **504** overlaps with the back-field lobe **406** within an area **B**. Similarly, the main lobe **404** overlaps with the back-field lobe **406** in an area **C**. Area **A** between pedestals **202a**, **202b** defines the EAS detection zone **250** in which active security tags should cause the EAS tag detection system **200** to generate an alarm response. Security tags in area **A** are stimulated by energy associated with an exciter signal within the main lobes **404**, **504** and will produce a response which can be detected at each antenna. The response produced by a security tag in area **A** is detected within the main lobes of each antenna and processed in the system controller **210**. Notably, a security tag in areas **B** or **C** will also be excited by the antennas **402**, **502**. The response signal produced by a security tag in these areas **B** and **C** will also be received at one or both antennas. This response signal is referred to herein as a “security tag signal”.

[0049] Illustrative Method For Synchronizing Incompatible Systems

[0050] Referring now to FIG. 7, there is provided a flow diagram of an illustrative method **700** for synchronizing operations of incompatible systems (e.g., AM based EAS systems **108**, **110** of FIG. 1). Method **700** begins with **702** and continues with **704** where receiver operations of a power supply (e.g., power supply **112** of FIG. 1) are programmed so that the power supply is interoperable with a BIM system (e.g., BIM system **150** of FIG. 1). Next in **706**, the power supply receives a wireless universal synchronization signal (e.g., signal **132** of FIG. 1) from the beacon (e.g., beacon **102** of FIG. 1) of the BIM system. The power supply determines a value for a phase offset setting of an internal signal conditioner circuit (e.g., signal conditioner circuit **122** of FIG. 1) based on information contained in the wireless universal synchronization signal,

as shown by **708**. In **710**, the power supply performs operations to apply the phase offset to an input AC power signal (e.g., input AC power signal **146** of FIG. 1) whereby a phase shifted AC signal (e.g., phase shifted AC signal **142** of FIG. 1) is generated. The phase shifted AC signal is buffered in **712** to generate an output AC power signal (e.g., output AC power signal **148** of FIG. 1). The output AC power signal is provided to a non-BIM compatible AM based EAS system (e.g., system **110** of FIG. 1) in **714**. The zero crossing of the output AC power signal is used to synchronize the non-BIM compatible AM based EAS system's transmit and receive operations with those of an adjacent BIM compatible AM based EAS system (e.g., system **108** of FIG. 1). Subsequently, **716** is performed where method **700** ends or other processing is performed (e.g., return to **706**).

[0051] Although the present solution has been illustrated and described with respect to one or more implementations, equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In addition, while a particular feature of the present solution may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application. Thus, the breadth and scope of the present solution should not be limited by any of the above described embodiments. Rather, the scope of the present solution should be defined in accordance with the following claims and their equivalents.

CLAIMS

What is claimed is:

1. A method for synchronizing operations of incompatible systems, comprising:
programming receiver operations of a power supply so that the power supply is interoperable with a first system of the incompatible systems;
receiving by the power supply a wireless universal synchronization signal from a beacon of the first system;
determining, by the power supply, a value for a phase offset setting of an internal signal conditioner circuit based on information contained in the wireless universal synchronization signal;
generating a phase shifted Alternating Current (“AC”) signal by applying a phase offset to an input AC power signal in accordance with the determined value for the phase offset setting;
buffering the phase shifted AC signal to generate an output AC power signal; and
using a zero crossing of the output AC power signal to synchronize transmit and receive operations of a second system of the incompatible systems with the first system’s transmit and receive operations.
2. The method according to claim 1, wherein the first system comprises a Business Intelligence Management (“BIM”) compatible system and the second system comprises a non-BIM compatible system.
3. The method according to claim 1, wherein the incompatible systems comprise Acousto-Magnetic (“AM”) based Electronic Article Surveillance (“EAS”) systems.
4. The method according to claim 3, wherein the AM based EAS systems comprise EAS tag detection systems.

5. The method according to claim 3, wherein the AM based EAS systems comprise EAS tag deactivation systems.

6. The method according to claim 1, wherein the value for a phase offset setting is determined by:

- generating a digital line reference signal using the information contained in the wireless universal synchronization signal;

- processing the digital line reference signal by a first Phase Lock Loop (“PLL”) to determine a first zero crossing location;

- processing the input AC power signal by a second PLL to determine a location of a second zero crossing location;

- determining a difference between the first and second zero crossing locations.

7. A power supply, comprising:

- a receiver configured to receive a wireless universal synchronization signal from a beacon of a first system of a plurality of incompatible systems;

- a circuit configured to:

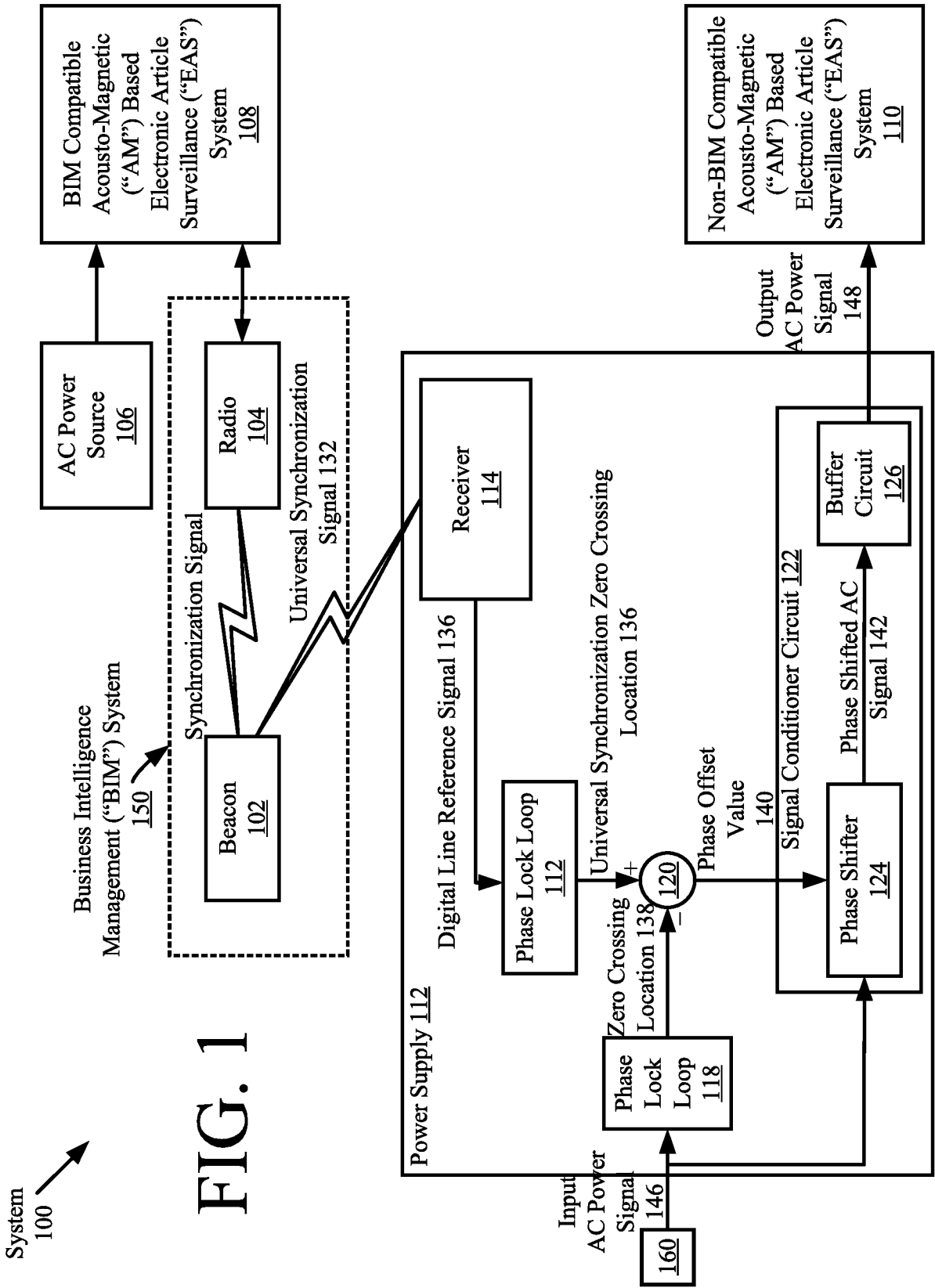
- determine a value for a phase offset setting of an internal signal conditioner circuit based on information contained in the wireless universal synchronization signal;

- generate a phase shifted Alternating Current (“AC”) signal by applying a phase offset to an input AC power signal in accordance with the determined value for the phase offset setting;

- buffer the phase shifted AC signal to generate an output AC power signal; and

- use a zero crossing of the output AC power signal to synchronize transmit and receive operations of a second system of the plurality of incompatible systems with the first system’s transmit and receive operations.

8. The power supply according to claim 7, wherein the first system comprises a Business Intelligence Management (“BIM”) compatible system and the second system comprises a non-BIM compatible system.
9. The power supply according to claim 7, wherein the incompatible systems comprise Acousto-Magnetic (“AM”) based Electronic Article Surveillance (“EAS”) systems.
10. The power supply according to claim 9, wherein the AM based EAS systems comprise EAS tag detection systems.
11. The power supply according to claim 9, wherein the AM based EAS systems comprise EAS tag deactivation systems.
12. The power supply according to claim 7, wherein the value for a phase offset setting is determined by:
 - generating a digital line reference signal using the information contained in the wireless universal synchronization signal;
 - processing the digital line reference signal by a first Phase Lock Loop (“PLL”) to determine a first zero crossing location;
 - processing the input AC power signal by a second PLL to determine a location of a second zero crossing location;
 - determining a difference between the first and second zero crossing locations.



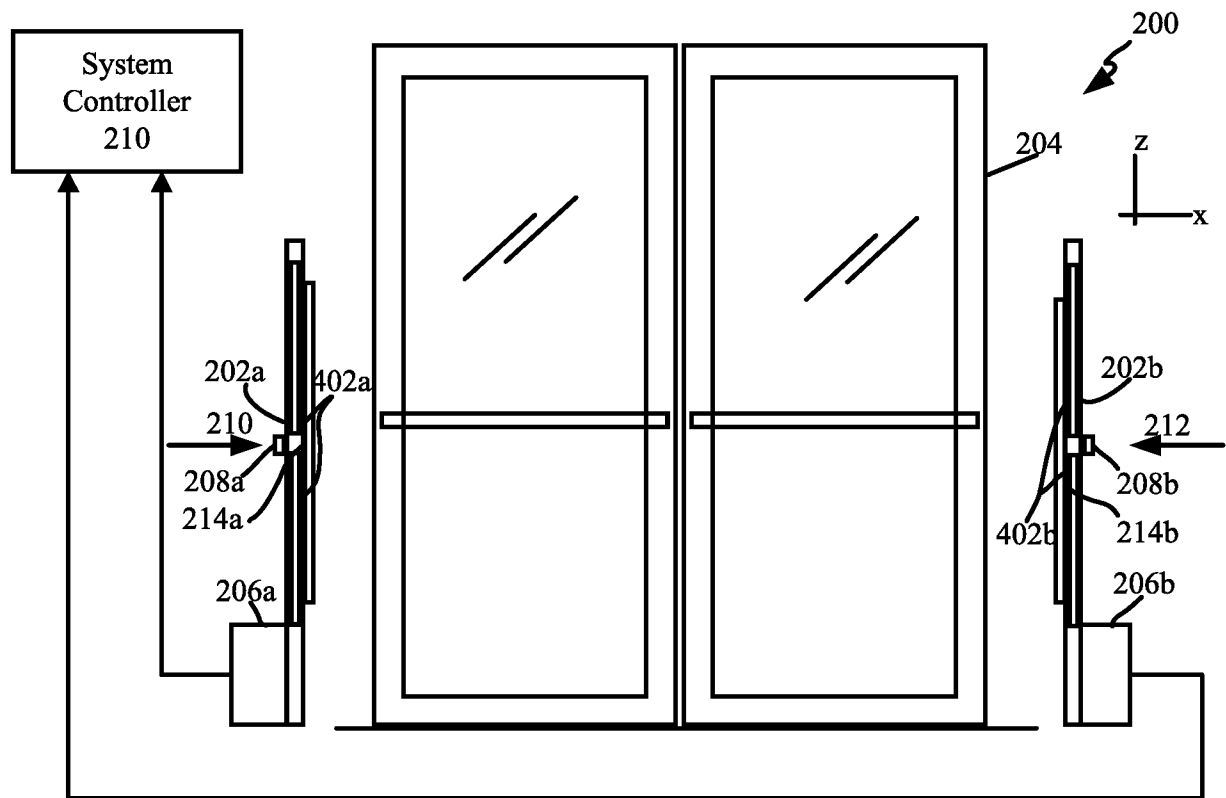


FIG. 2

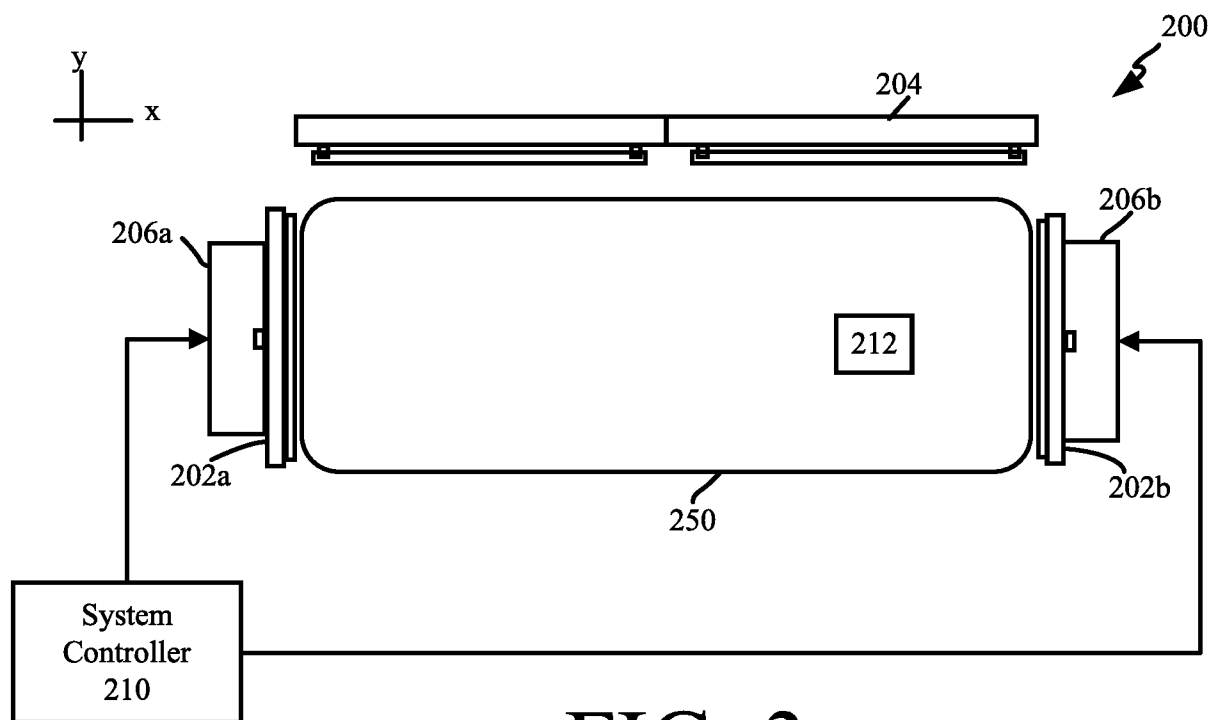


FIG. 3

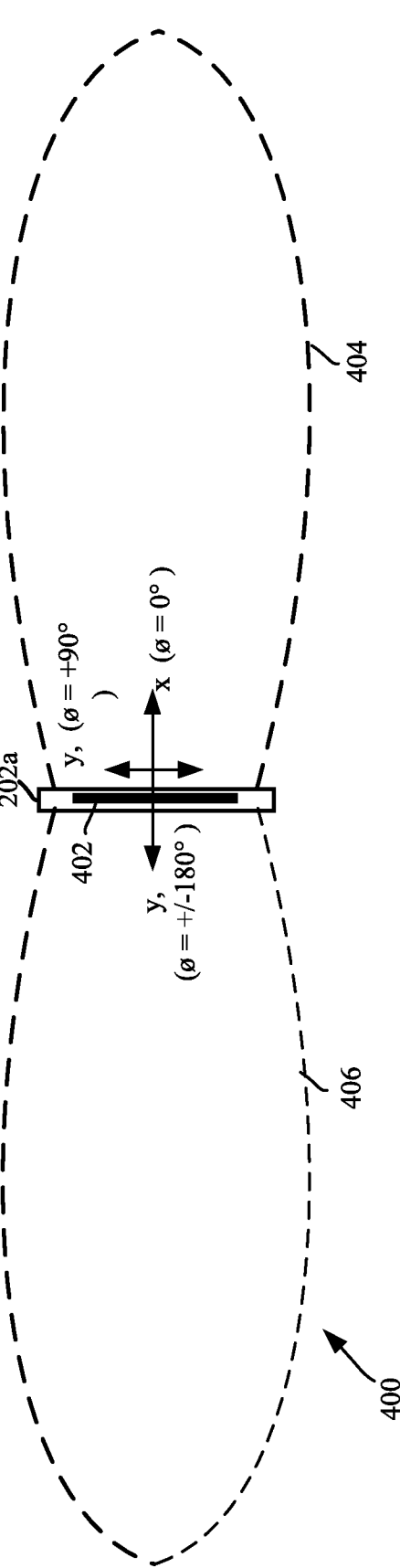


FIG. 4

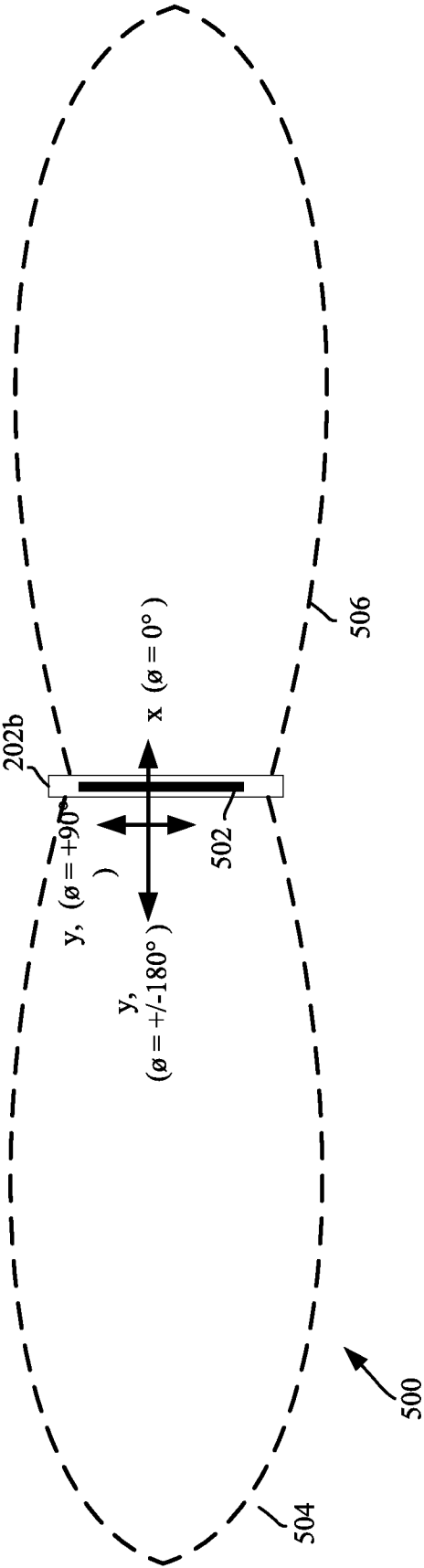


FIG. 5

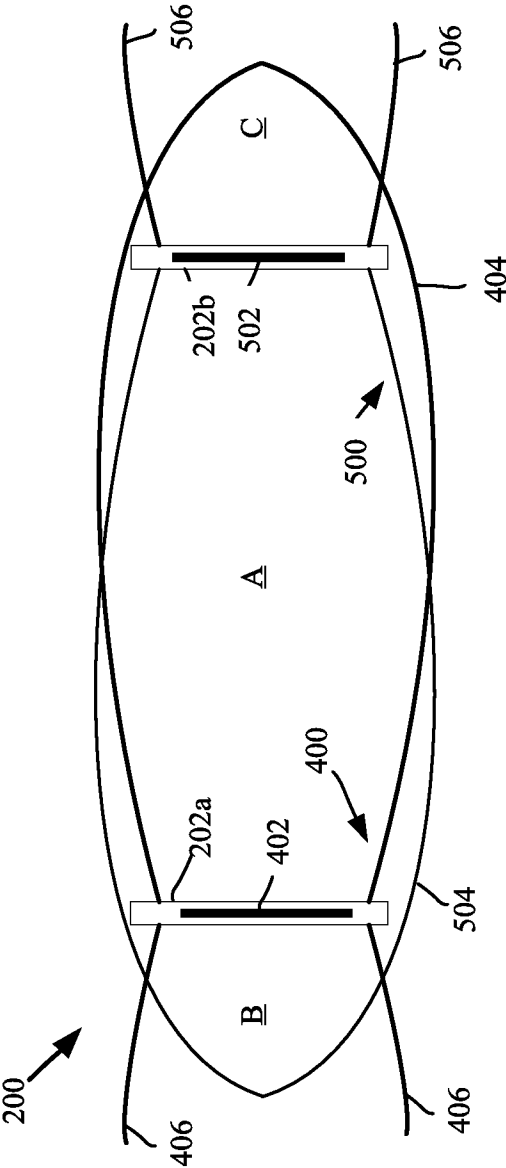


FIG. 6

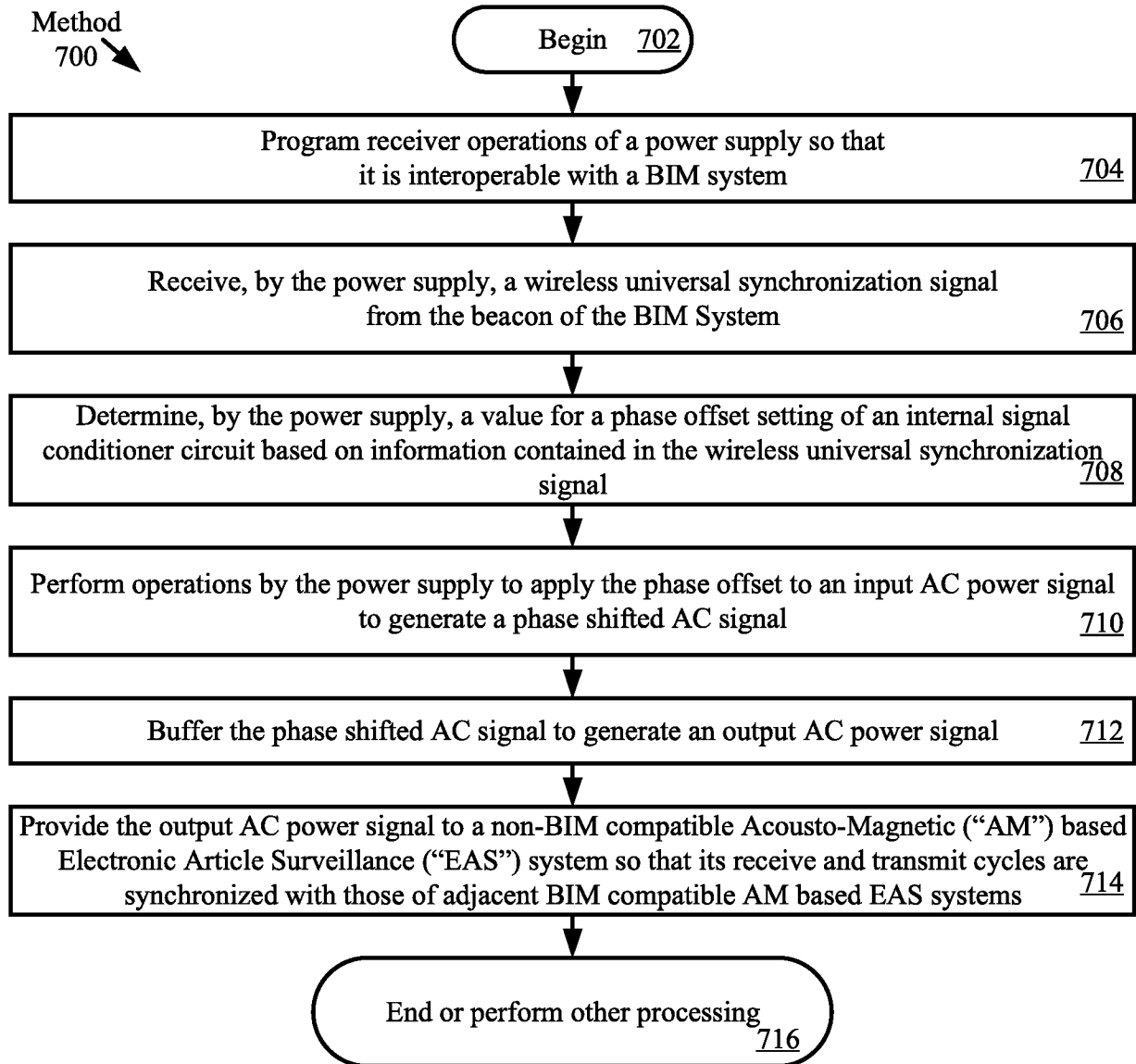


FIG. 7

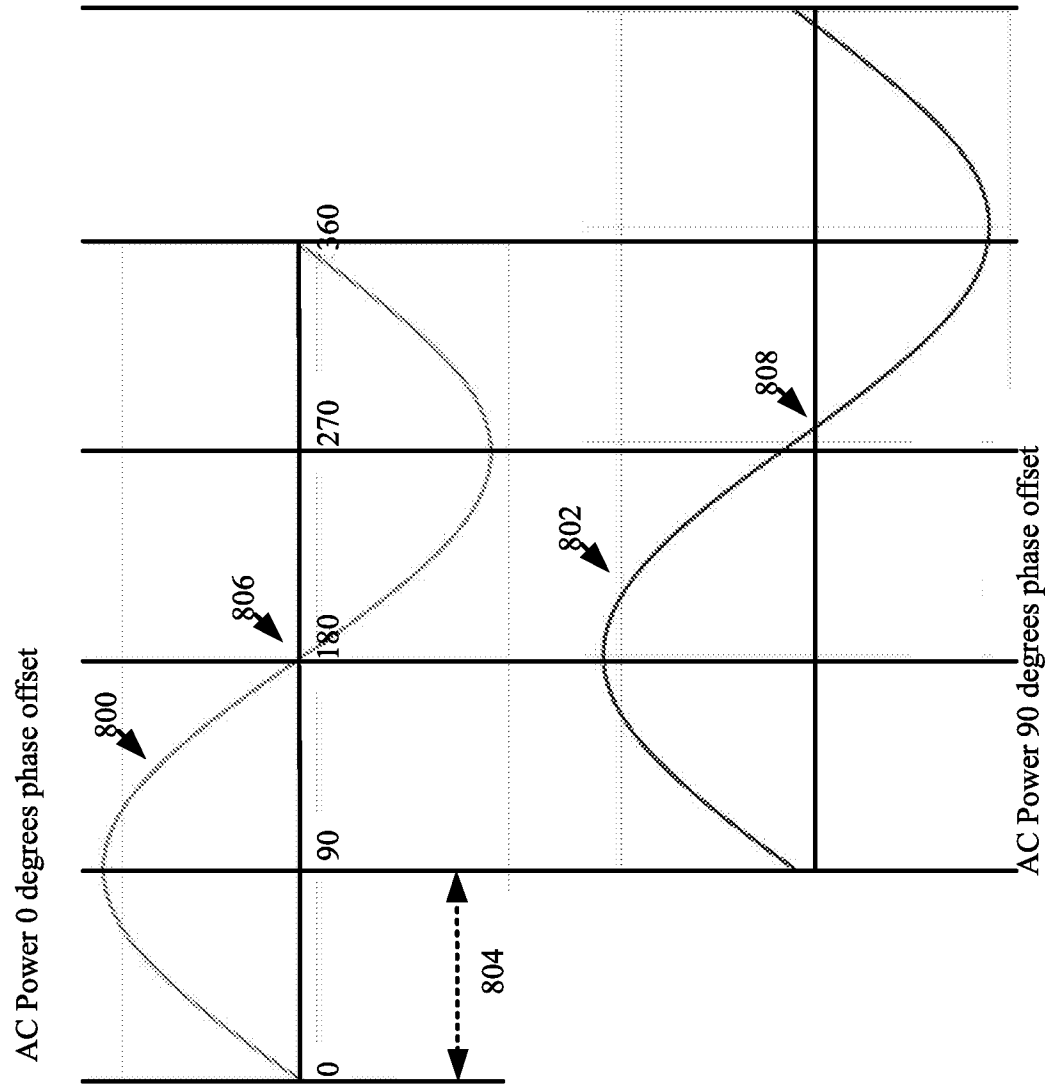


FIG. 8

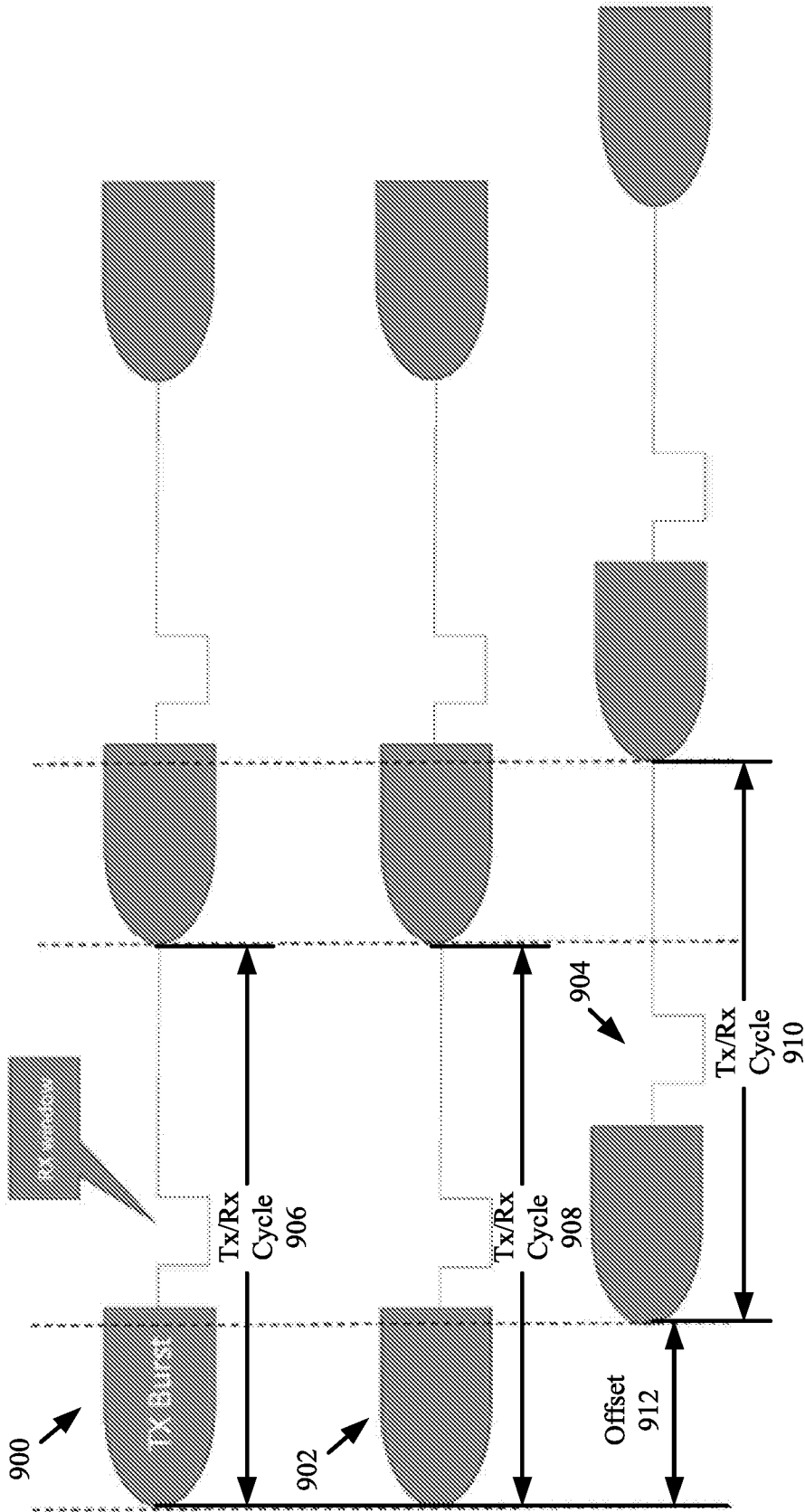


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/041949

A. CLASSIFICATION OF SUBJECT MATTER
INV. G08B13/24
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 995 002 A (FALLIN DAVID [US] ET AL) 30 November 1999 (1999-11-30)	1,7
Y	column 1, lines 28-42 column 2, line 36 - column 3, line 60 column 4, line 27 - column 5, line 20 -----	3-6,9-12
Y	WO 01/78028 A2 (SENSORMATIC ELECTRONICS CORP [US]) 18 October 2001 (2001-10-18) page 5, lines 21-27 -----	3-5,9-11
Y	WO 02/063771 A2 (SENSORMATIC ELECTRONICS CORP [US]) 15 August 2002 (2002-08-15) page 4, lines 1,2 -----	6,12



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

5 November 2019

Date of mailing of the international search report

13/11/2019

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Dascalu, Aurel

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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