(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 040 905 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
14.02.2018 Bulletin 2018/07

(51) Int Cl.:
G06K 7/10 *(2006.01)*

(21) Application number: **15200978.3**

(22) Date of filing: **17.12.2015**

(54) **MODULATION INDEX (DEPTH) BASED GROUPING, ADDRESSING, AND FINGERPRINTING RFID TAGS**

AUF MODULATIONSINDEX (TIEFE) BASIERENDE RFID-ETIKETTEN ZUR GRUPPIERUNG, ADRESSIERUNG UND FINGERABDRUCKNAHME

GROUPAGE À BASE D'INDICE DE MODULATION (PROFONDEUR), ADRESSAGE ET ÉTIQUETTES RFID DE DACTYLOSCOPIE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **31.12.2014 US 201414587772**

(43) Date of publication of application:
06.07.2016 Bulletin 2016/27

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(56) References cited:
US-A1- 2011 163 855 **US-A1- 2013 241 716**

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Description

BACKGROUND

[0001] RFID tags are commonly used to identify persons or goods. RFID tags are usually designed to be compact and not require a battery. Due to these design constraints, RFID tags generally do not have sophisticated memory or processing capability. As a result, nearly all of the processing, management, and power functionality must be provided by the RFID reader. This can be overly burdensome on the reader, particularly if a large number of tags are within range of the reader, which occurs frequently in commercial applications. The reader must handle the volume of communications generated by the tags, organize and identify the tags, and send communications to specific tags. Additionally, if more than one tag responds simultaneously to a query, they will interfere with each other. For this reason, tag identification is an important reader function.

[0002] RFID readers use a method called singulation to identify specific tags within a group of tags within range. The singulation protocol or anti-collision protocol prevents tags from interfering with each other, allowing the reader to read data from each tag.

[0003] EPC Class 1, Generation 2 (Gen2 protocol) RFID devices use an algorithm similar to slotted ALOHA, called Q-algorithm for singulation. The Q-algorithm is illustrated in FIG. 1. In the Q-algorithm, a Q-parameter is created and all tags are instructed to create a random number for the counter, between 0 and 2^Q-1. The reader then instructs each tag to respond only if its random number is zero, otherwise to decrement its random number by one for the next round. The critical part of the algorithm is initial value of Q. If Q is too large, time will be wasted while tags decrement their random numbers to zero. If it is too small, some tags may guess the same random number, will collide, and will need to be re-identified. In either case, singulation time can be long if the number of tags is very different from 2^Q. All current approaches to determining Q are blind adaptive methods which include some initial guess of Q and its further refinement.

[0004] After singulation is finished, tags can be addressed individually (by their EPC IDs) and told to stay quiet (for this purpose, special bits called session inventory flags are used). However, these flags expire (typically, in several minutes) and reset to defaults due to discharge of internal tag capacitors.

[0005] There remains a need in the art for a reliably faster and more permanent method of identifying RFID tags.

[0006] United States Patent Application US2011/163855 discloses a contactless IC card reader which transmits signals composed of amplitude modulated carrier signals to a contactless IC card, the contactless IC card and reader communicate by means of an NRZ encoding method and an ASK modulating method for which the modulation depth has an arbitrary value. United States Patent Application US 2013/241716 discloses a transmitter in an RFID system, which includes a signal generator which receives a second control signal to control a modulation depth of a first signal.

SUMMARY

[0007] The present invention in its various aspects is as set out in the appended claims.

[0008] A method of addressing one or more RFID devices within a group of RFID devices includes transmitting a command to respond to the group at a first modulation depth. The method further includes receiving a response from a first sub-group of RFID devices in the group that have a minimum modulation depth less than or equal to the first modulation depth. The method further includes transmitting the command to respond to the group at a second modulation depth higher than the first modulation depth. The method further includes receiving a response from a second sub-group of RFID devices within the group that have a minimum modulation depth less than or equal to the second modulation depth.

[0009] In some embodiments, the method further includes performing singulation on the first sub-group. In some embodiments, the singulation is performed using the Q-algorithm. In some embodiments, the method further includes associating the first sub-group of RFID devices with a first category of products, and associating the second sub-group of RFID devices with a second category of products. In some embodiments, the method further includes identifying a product based on a minimum modulation depth of an RFID device associated with the product. In some embodiments, the method further includes placing one of the first sub-group of RFID devices in a first location, placing one of the second sub-group of RFID devices in a second location, and identifying the first or second location based on a minimum modulation depth of the RFID device at that location.

[0010] An RFID system includes a first group of RFID devices having a first minimum modulation depth. The system further includes a second group of RFID devices having a second minimum modulation depth higher than the first minimum modulation depth. The system further includes an RFID communicator having a transmitter that transmits signals to the RFID devices. The RFID communicator further includes a controller that uses the transmitter to send a first signal to the RFID devices at a first modulation depth, and send a second signal to the RFID devices at a second modulation depth. The first modulation depth is greater than or equal to the first minimum modulation depth and less than the second minimum modulation depth. The second modulation depth is greater than or equal to the second minimum modulation depth. The first group of RFID devices respond to the first and second signals. The second group

of RFID devices respond to the second signal and do not respond to the first signal.

[0011] In some embodiments, the controller singulates the first group of RFID devices. In some embodiments, the controller uses the Q-algorithm to singulate the first group of RFID devices. In some embodiments, the RFID communicator further includes a receiver that receives signals from the RFID devices. In some embodiments, the controller demodulates signals received with the receiver. In some embodiments, the signals are amplitude modulated. In some embodiments, the system further includes an RFID device with a minimum modulation depth that is stored in the controller. In some embodiments, the minimum modulation depth of at least one of the groups of RFID devices is between 39% and 54%. In some embodiments, the signals have a carrier frequency between 30 and 300 KHz. In some embodiments, the signals have a carrier frequency between 30 KHz and 300 KHz. In some embodiments, the signals have a carrier frequency between 3 and 30 MHz. In some embodiments, the signals have a carrier frequency between 300 MHz and 3 GHz.

[0012] A method of authenticating an RFID identification includes transmitting a command to respond to an RFID device installed on the RFID identification at a first modulation depth. The method further includes repeating the following steps until a response is received from the RFID device to determine a measured minimum modulation depth of the RFID identification: determining if a response is received from the RFID device; and transmitting a command to respond to the RFID device at an incrementally higher modulation depth. The method further includes receiving identifying information from the RFID device. The method further includes obtaining a known minimum modulation depth of the RFID identification using the identifying information. The method further includes comparing the measured minimum modulation depth to the known minimum modulation depth. The method further includes determining that the RFID identification is not authentic if the measured minimum modulation depth is sufficiently different from the known minimum modulation depth.

[0013] In some embodiments, the first modulation depth is a value known to be lower than the minimum modulation depth of all RFID identifications. In some embodiments, the identification is a box label. In some embodiments, the identification is a personal photograph identification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

FIG. 1 is a flowchart of the prior art Q-algorithm.
FIG. 2 is a graph of a modulated reader signal according to one embodiment.
FIG. 3 is a diagram of a system according to one embodiment.
FIG. 4 is an exploded view and an angled isometric view of a tag according to one embodiment installed in a personal identification.
FIG. 5 is a system according to one embodiment installed in a work environment.
FIG. 6 is an angled isometric view of a tag according to one embodiment installed on a box.
FIG. 7 is a flowchart of a method according to one embodiment.
FIG. 8 is a block diagram of an RFID reader according to one embodiment.
FIG. 9 is a flowchart of a method according to one embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0015] Many wireless transmitters, including RFID systems, use signal modulation to transmit information. A modulated signal includes a carrier wave and a signal wave. The carrier wave is generally a predictable repeating wave. The signal wave is added to the carrier wave, which alters the carrier wave from its normal characteristics. This combined wave is transmitted wirelessly and received by a receiver. The receiver is configured to receive the carrier wave and subtracts the carrier wave from the signal wave (demodulating the signal). The receiver can thereby read the information contained in the signal wave. Modulation may include amplitude modulation, frequency modulation, phase modulation, etc... In the examples given herein, amplitude modulation is used. In the amplitude modulation example, the combined wave envelope is the signal wave, so the receiver uses an envelope detector to demodulate the combined wave.

[0016] Modulation depth m is defined as the modulation amplitude divided by the carrier signal amplitude, expressed as a percentage. The modulation amplitude is the peak (positive or negative) change in the RF amplitude from its unmodulated value. Therefore, a modulation depth m=100% indicates a signal wave envelope that varies between zero and twice the normal amplitude of the carrier signal. A modulation depth of m=50% a signal wave envelope that varies between 50% and 100% of the normal amplitude of the carrier signal. A modulation depth of m=0% would indicate that no signal wave is being transmitted. FIG. 2 shows the voltage V_0 of a combined wave envelope over time for a modulated signal having a modulation index $0<m<1$ (i.e. a modulation depth of $0\%<m<100\%$).

[0017] Each RFID tag has individual properties of antenna-chip impedance matching (resulting from manufacturing tolerances and discrepancies between individual integrated circuits (ICs), antennas, packaging, etc...) and specific

parameters of the charge pump and demodulator circuitry. Therefore, each RFID tag has its own threshold minimum modulation depth m_0 for the received reader signal needed in order to successfully decode the command and respond. When the modulation depth m of the signal is smaller than this threshold value ($m<m_0$), the tag IC does not respond because it treats the demodulated signal with very low modulation depth as simply noise or as an invalid signal. However, the RFID tag continues to receive the carrier wave and remains powered on. In other words, minimum required modulation depth m_0 is a physical characteristic unique to each tag, and each RFID tag will not respond to any signal having a modulation depth lower than its unique m_0.

[0018] Because minimum required modulation depth m_0 is a physical characteristic unique to each tag, modulation depth can be used by the RFID reader to differentiate tags. Moreover, specific makes and models of tags have m_0 values that are in many cases similar to other units of that same make and model. This means that a system may contain variety of makes and models and address subgroups of tags based on their make and model.

[0019] Table 1 includes data for a list of exemplary RFID tags of different makes and models with different integrated circuit models. Table 1 shows the sensitivity and minimum modulation depth m_0 for each RFID tag.

TABLE 1

Tag Make	Tag Model	IC Model	Tag Sensitivity	m_0
A	w	1	-12.3 dBm	39%
B	x	1	-12.9 dBm	43%
C	y	1	-12.2 dBm	54%
A	z	2	-15.8 dBm	48%

[0020] In this example, all of the tags shown in Table 1 are within range of the RFID reader. The reader transmits a command with Q=0 (instructing all tags to respond) but with the modulation depth m=40%. Only the tag Aw (Make A, model w) will respond to it, because m is lower than the *mo* values for all of the other tags. Increasing the modulation depth to 45% (and using exactly the same command) will cause the tag Bx to respond. As m is increased, more tags will respond until an m value of at least 54% is used (m_0 of tag Cy with the highest m_0), at which point all of the tags will respond. This allows the reader to exclusively address sub-groups of tags as shown in FIG. 3.

[0021] FIG. 3 shows a system according to one embodiment. The system includes an RFID reader 30, which includes transmitter Tx, circulator 32, antenna 34, and receiver Rx. RFID reader 30 transmits signal 36 wirelessly to RFID tags 38 that are within range. In this embodiment, RFID reader 30 transmits a first signal at 30% modulation depth, which causes shaded tags 1, 3, and 5 to respond. RFID reader 30 can address tags 1, 3, and 5 at a 30% modulation depth, because tags 1, 3, and 5 have a minimum modulation depth (m_0) of less than or equal to 30%. Unshaded tags 2, 4, and 6 have an m_0 of greater than 30%, and will ignore the first signal because its modulation depth is too low. RFID reader 30 sends a second signal at a modulation depth of 70%. Since tags 1-6 all have an m_0 of less than or equal to 70%, all tags 38 (including tags 2, 4, and 6) respond to the second signal. In this way, reader 30 can address different subgroups of tags 38. In some embodiments, calibration tags 38 that have known minimum modulation depths are included in tag population to improve identification accuracy.

[0022] FIG. 7 shows a flowchart of a method of addressing one or more RFID devices within a group of RFID devices. Step S70 includes transmitting a command to respond to the group at a first modulation depth. Step S72 includes receiving a response from a first sub-group of RFID devices in the group that have a minimum modulation depth less than or equal to the first modulation depth. Step S74 includes transmitting the command to respond to the group at a second modulation depth higher than the first modulation depth. Step S76 includes receiving a response from a second sub-group of RFID devices within the group that have a minimum modulation depth less than or equal to the second modulation depth. Step S77 includes associating the first sub-group of RFID devices with a first category of products. Step S78 includes associating the second sub-group of RFID devices with a second category of products. Step S79 includes identifying a product based on a minimum modulation depth of an RFID device associated with the product.

[0023] FIG. 8 shows an RFID reader 30 according to one embodiment. In this embodiment reader 30 comprises controller 80 that controls the signals 36 that are transmitted from reader 30 using transmitter Tx. Controller 80 sets the modulation depth m of each signal transmitted from reader 30. Controller 80 can thereby address specific sub-groups of tags 38 based on modulation depth m, as described herein. Controller 80 also receives communications from tags 38 via receiver Rx. Controller 80 can modulate transmitted signals and demodulate received signals. In some embodiments, controller 80 uses amplitude modulation. In some embodiments, controller 80 also singulates groups of RFID tags using the Q-algorithm. Controller 80 may be a computer, ASIC, microcontroller, or other device capable of performing the tasks described herein. Controller 80 may include a CPU, RAM, ROM, storage media, signal processors, A/D converters, D/A converters, or any other necessary hardware components.

[0024] In FIG. 5, tags 1-6 from FIG. 3 have been installed on opposing shelve rows 50, 52 of a grocery store or warehouse aisle 54. Tags 2, 4, and 6 are installed on row 52, and tags 1, 3, and 5 are installed on row 50. In various embodiments, tags 1-6 are installed in specific locations on rows 50 and 52 or are installed on individual product packages. Because tags 1, 3, and 5 and 2, 4, and 6 respond as groups to different signal modulation depths, they can be addressed separately. Therefore, if an operator desires to scan, track, or locate products in a specific row 50, 52, it is possible to do so by varying signal modulation depth as described herein. The locations of operators within a facility can also be tracked based on which RFIDs are in their vicinity.

[0025] FIGS. 4 and 6 show RFID tags integrated into physical identifications. In FIG. 4, an RFID tag is integrated into a passport 40. RFID tag is included on RFID tag layer 44, which includes an antenna, and a contactless module 42 comprising an integrated circuit. Passport 40 also includes the photo ID layer 46, cover 49, and protective layer 48. If any of these layers are altered or tampered with, the m_0 of the RFID tag in passport 44 will change. RFID reader 30 will either detect this change or fail to communicate with the RFID tag at all once the m_0 is changed from its original value. This change in m_0 occurs because tampering disturbs the antenna/packaging impedance matching and other characteristics of the RFID circuitry. Therefore, reader 30 can determine if the passport 40 (which has all correct ID and data) is truly authentic if the original m_0 for the passport 40 is known. This alteration of the m_0 will not be apparent to most counterfeiters, making it a hidden security feature.

[0026] In FIG. 6, an RFID tag is integrated into a box label 62 on box 60. RFID tags with different minimum modulation depths can be attached to different product packages and be used to identify different products or categories of products. If label 62 is tampered with (i.e. by removal and reapplication on another box), the m_0 will be altered. As with the photo ID example, RFID reader 30 will either detect this change or fail to communicate with the RFID tag at all once the m_0 is changed from its original value. This alteration of the m_0 will not be apparent to most smugglers or thieves, making it a hidden security feature.

[0027] According to one embodiment, an RFID identification 40, 62 can be authenticated by incrementally increasing the modulation depth of the signal, starting at value known to be lower than the m_0 of all RFID tags. The modulation depth of the first signal at which reader 30 receives a response will be the measured minimum modulation depth. Once communication is established, identification information is obtained from the RFID tag. This identification information is used to look up a known minimum modulation depth of the RFID identification. If the known minimum modulation depth differs sufficiently from the measured minimum modulation depth, this is evidence of tampering or counterfeiting and can be used as a basis for rejecting the RFID identification.

[0028] FIG. 9 shows a method of authenticating an RFID identification. Step S90 includes transmitting a command to respond to an RFID device installed on the RFID identification. Step S91 includes determining if a response is received from the RFID device. Step S92 includes incrementally increasing the modulation depth if no response is received from the RFID device. Steps S90-S92 are repeated until a response is received from the RFID device in Step S91. The measured minimum modulation depth is the modulation depth at which a response is first received from the RFID device. Step S93 includes receiving identifying information from the RFID device if a response is received from the RFID device. Step S94 includes obtaining a known minimum modulation depth of the RFID identification using the identifying information. Step S95 includes comparing the measured minimum modulation depth to the known minimum modulation depth to determine if the measured minimum modulation depth is sufficiently close to the known minimum modulation depth. Step S96 includes determining that the RFID identification is not authentic if the measured minimum modulation depth is not sufficiently close to the known minimum modulation depth. Step S97 includes determining that the RFID identification is authentic if the measured minimum modulation depth is sufficiently close to the known minimum modulation depth.

[0029] The systems and methods described herein have several advantageous features. First, they provide the ability to address subgroups of tags directly without full singulation of their EPC IDs. After this is completed, tags can be singulated using other methods, but in smaller groups. This results in faster singulation and faster tag read rate. Second, the methods result in physically tamper-resistant authentication. Third, they provide the ability to address and maintain subgroups of tags indefinitely. In current Gen2 protocol, group markers (called persistence flags) expire in several minutes and reset to defaults due to discharge of internal tag capacitors. The m_0 is a permanent identifying feature of each tag, which does not expire.

[0030] The methods described herein can be implemented in current RFID readers. The methods described herein can also be used for RFID systems have a low carrier frequency (30 KHz to 300 KHz), high carrier frequency (3 to 30 MHz), and ultra-high carrier frequency (300 MHz to 3 GHz).

[0031] Although the invention has been described with reference to embodiments herein, those embodiments do not limit the scope of the invention. Modifications to those embodiments or different embodiments may fall within the scope of the invention.

Claims

1. A method of addressing one or more RFID devices (38) within a group of RFID devices (38), comprising:

   transmitting a command to respond to the group at a first modulation depth (S70);
   receiving a response from a first sub-group of RFID devices in the group that have a minimum modulation depth less than or equal to the first modulation depth (S72);
   transmitting the command to respond to the group at a second modulation depth higher than the first modulation depth (S74); and
   receiving a response from a second sub-group of RFID devices within the group that have a minimum modulation depth less than or equal to the second modulation depth (S76).

2. The method of claim 1, further comprising:

   performing singulation on the first sub-group.

3. The method of claim 2, wherein the singulation is performed using the Q-algorithm.

4. The method of claim 1, further comprising:

   associating the first sub-group of RFID devices (38) with a first category of products (S77); and
   associating the second sub-group of RFID devices (38) with a second category of products (S78).

5. The method of claim 4, further comprising:

   identifying a product based on a minimum modulation depth of an RFID device (38) associated with the product (S79).

6. The method of claim 1, further comprising:

   placing one of the first sub-group of RFID devices (38) in a first location (50);
   placing one of the second sub-group of RFID devices (38) in a second location (52); and
   identifying the first or second location (50, 52) based on a minimum modulation depth of the RFID device (38) at that location (50, 52).

7. An RFID system, comprising;
   a first group of RFID devices (38) having a first minimum modulation depth;
   a second group of RFID devices (38) having a second minimum modulation depth higher than the first minimum modulation depth; and
   an RFID communicator (30) having:

   a transmitter (Tx) that transmits signals (36) to the RFID devices (38); and **characterized by** having:

   a controller (80) that uses the transmitter (Tx) to send a first signal (36) to the RFID devices (38) at a first modulation depth, and send a second signal (36) to the RFID devices (38) at a second modulation depth;

   the first modulation depth being greater than or equal to the first minimum modulation depth and less than the second minimum modulation depth;
   the second modulation depth being greater than or equal to the second minimum modulation depth;
   the first group of RFID devices (38) responding to the first and second signals (36); and
   the second group of RFID devices (38) responding to the second signal (36) and not responding to the first signal (36).

8. The system of claim 7, wherein the controller (80) singulates the first group of RFID devices (38).

9. The system of claim 8, wherein the controller (80) uses the Q-algorithm to singulate the first group of RFID devices (38).

10. The system of claim 7, wherein the RFID communicator (30) further includes:

a receiver (Rx) that receives signals from the RFID devices (38).

11. The system of claim 10, wherein the controller (80) demodulates signals received with the receiver (Rx).

12. The system of claim 7, wherein the signals (36) are amplitude modulated.

13. The system of claim 7, further comprising:

an RFID device (38) having a minimum modulation depth that is stored in the controller (80).

14. The system of claim 7, wherein the minimum modulation depth of at least one of the groups of RFID devices (38) is between 39% and 54%.

15. The system of claim 7, wherein the signals (36) have a carrier frequency between 30 and 300 KHz.

Patentansprüche

1. Verfahren zur Adressierung einer oder mehrerer RFID-Vorrichtungen (38) innerhalb einer Gruppe von RFID-Vorrichtungen (38), umfassend:

Senden eines Befehls zum Antworten an die Gruppe bei einer ersten Modulationstiefe (S70);
Empfangen einer Antwort von einer ersten Teilgruppe von RFID-Vorrichtungen in der Gruppe, die eine minimale Modulationstiefe aufweisen, die geringer als oder gleich wie die erste Modulationstiefe ist (S72) ;
Senden des Befehls zum Antworten an die Gruppe bei einer zweiten Modulationstiefe, die höher als die erste Modulationstiefe ist (S74); und
Empfangen einer Antwort von einer zweiten Teilgruppe von RFID-Vorrichtungen innerhalb der Gruppe, die eine minimale Modulationstiefe aufweisen, die geringer als oder gleich wie die zweite Modulationstiefe ist (S76).

2. Verfahren nach Anspruch 1, ferner umfassend:

Durchführen von Vereinzelung an der ersten Teilgruppe.

3. Verfahren nach Anspruch 2, wobei die Vereinzelung unter Verwendung des Q-Algorithmus durchgeführt wird.

4. Verfahren nach Anspruch 1, ferner umfassend:

Assoziieren der ersten Teilgruppe von RFID-Vorrichtungen (38) mit einer ersten Kategorie von Produkten (S77); und
Assoziieren der zweiten Teilgruppe von RFID-Vorrichtungen (38) mit einer zweiten Kategorie von Produkten (S78).

5. Verfahren nach Anspruch 4, ferner umfassend:

Identifizieren eines Produkts basierend auf einer minimalen Modulationstiefe einer RFID-Vorrichtung (38), die mit dem Produkt assoziiert ist (S79).

6. Verfahren nach Anspruch 1, ferner umfassend:

Anordnen einer der ersten Teilgruppe von RFID-Vorrichtungen (38) an einem ersten Ort (50);
Anordnen einer der zweiten Teilgruppe von RFID-Vorrichtungen (38) an einem zweiten Ort (52); und
Identifizieren des ersten oder zweiten Orts (50, 52) basierend auf einer minimalen Modulationstiefe der RFID-Vorrichtung (38) an diesem Ort (50, 52).

7. RFID-System, umfassend:

eine erste Gruppe von RFID-Vorrichtungen (38) mit einer ersten minimalen Modulationstiefe;
eine zweite Gruppe von RFID-Vorrichtungen (38) mit einer zweiten minimalen Modulationstiefe, die höher als

die erste minimale Modulationstiefe ist; und
einen RFID-Kommunikator (30), der aufweist:

einen Sender (Tx), der Signale (36) an die RFID-Vorrichtungen (38) sendet; und **gekennzeichnet durch** Aufweisen:

einer Steuerung (80), die den Sender (Tx) zum Senden eines ersten Signals (36) an die RFID-Vorrichtungen (38) bei einer ersten Modulationstiefe und Senden eines zweiten Signals (36) an die RFID-Vorrichtungen (38) bei einer zweiten Modulationstiefe verwendet;

wobei die erste Modulationstiefe größer als oder gleich wie die erste minimale Modulationstiefe und geringer als die zweite minimale Modulationstiefe ist;
die zweite Modulationstiefe größer als oder gleich wie die zweite minimale Modulationstiefe ist;
die erste Gruppe von RFID-Vorrichtungen (38) auf die ersten und zweiten Signale (36) anspricht; und
die zweite Gruppe von RFID-Vorrichtungen (38) auf das zweite Signal (36) anspricht, und nicht auf das erste Signal (36) anspricht.

8. System nach Anspruch 7, wobei die Steuerung (80) die erste Gruppe von RFID-Vorrichtungen (38) vereinzelt.

9. System nach Anspruch 8, wobei die Steuerung (80) den Q-Algorithmus zum Vereinzeln der ersten Gruppe von RFID-Vorrichtungen (38) verwendet.

10. System nach Anspruch 7, wobei der RFID-Kommunikator (30) ferner umfasst:

einen Empfänger (Rx), der Signale von den RFID-Vorrichtungen (38) empfängt.

11. System nach Anspruch 10, wobei die Steuerung (80) Signale demoduliert, die mit dem Empfänger (Rx) empfangen werden.

12. System nach Anspruch 7, wobei die Signale (36) amplitudenmoduliert sind.

13. System nach Anspruch 7, ferner umfassend:

eine RFID-Vorrichtung (38) mit einer minimalen Modulationstiefe, die in der Steuerung (80) gespeichert ist.

14. System nach Anspruch 7, wobei die minimale Modulationstiefe mindestens einer der Gruppen von RFID-Vorrichtungen (38) zwischen 39% und 54% liegt.

15. System nach Anspruch 7, wobei die Signale (36) eine Trägerfrequenz von 30 bis 300 kHz aufweisen.

Revendications

1. Procédé d'adressage d'un ou de plusieurs dispositifs RFID (38) dans un groupe de dispositifs RFID (38), comprenant :

la transmission d'une commande pour répondre au groupe à une première profondeur de modulation (S70) ;
la réception d'une réponse depuis un premier sous-groupe de dispositifs RFID dans le groupe qui a une profondeur de modulation minimum inférieure ou égale à la première profondeur de modulation (S72) ;
la transmission de la commande pour répondre au groupe à une seconde profondeur de modulation supérieure à la première profondeur de modulation (S74) ; et
la réception d'une réponse depuis un second sous-groupe de dispositifs RFID dans le groupe qui a une profondeur de modulation minimum inférieure ou égale à la seconde profondeur de modulation (S76).

2. Procédé selon la revendication 1, comprenant en outre :

l'exécution d'une séparation sur le premier sous-groupe.

3. Procédé selon la revendication 2, dans lequel la séparation est exécutée à l'aide de l'algorithme Q.

4. Procédé selon la revendication 1, comprenant en outre :

l'association du premier sous-groupe de dispositifs RFID (38) à une première catégorie de produits (S77) ; et
l'association du second sous-groupe de dispositifs RFID (38) à une seconde catégorie de produits (S78) .

5. Procédé selon la revendication 4, comprenant en outre :

l'identification d'un produit en fonction d'une profondeur de modulation minimum d'un dispositif RFID (38) associé au produit (S79).

6. Procédé selon la revendication 1, comprenant en outre :

le placement de l'un du premier sous-groupe de dispositifs RFID (38) à un premier emplacement (50) ;
le placement de l'un du second sous-groupe de dispositifs RFID (38) à un second emplacement (52) ; et
l'identification du premier ou second emplacement (50, 52) en fonction d'une profondeur de modulation minimum du dispositif RFID (38) à cet emplacement (50, 52).

7. Système RFID, comprenant :

un premier groupe de dispositifs RFID (38) ayant une première profondeur de modulation minimum ;
un second groupe de dispositifs RFID (38) ayant une seconde profondeur de modulation minimum supérieure à la première profondeur de modulation minimum ; et
un communicateur RFID (30) ayant :

un émetteur (Tx) qui transmet des signaux (36) aux dispositifs RFID (38) ;

et **caractérisé en ce qu'**il comprend :

un contrôleur (80) qui utilise l'émetteur (Tx) pour envoyer un premier signal (36) aux dispositifs RFID (38) à une première profondeur de modulation, et envoyer un second signal (36) aux dispositifs RFID (38) à une seconde profondeur de modulation ;

la première profondeur de modulation étant supérieure ou égale à la première profondeur de modulation minimum et inférieure à la seconde profondeur de modulation minimum ;
la seconde profondeur de modulation étant supérieure ou égale à la seconde profondeur de modulation ;
le premier groupe de dispositifs RFID (38) répondant aux premier et second signaux (36) ; et
le second groupe de dispositifs RFID (38) répondant au second signal (36) et ne répondant pas au premier signal (36).

8. Système selon la revendication 7, dans lequel le contrôleur (80) sépare le premier groupe de dispositifs RFID (38).

9. Système selon la revendication 8, dans lequel le contrôleur (80) utilise l'algorithme Q pour séparer le premier groupe de dispositifs RFID (38) .

10. Système selon la revendication 7, dans lequel le communicateur RFID (30) comporte en outre :

un récepteur qui reçoit des signaux des dispositifs RFID (38).

11. Système selon la revendication 10, dans lequel le contrôleur (80) démodule les signaux reçus avec le récepteur (Rx).

12. Système selon la revendication 7, dans lequel les signaux (36) sont modulés en amplitude.

13. Système selon la revendication 7, comprenant en outre :

un dispositif RFID (38) ayant une profondeur de modulation minimum qui est mémorisée dans le contrôleur (80).

14. Système selon la revendication 7, dans lequel la profondeur de modulation minimum d'au moins l'un des groupes de dispositifs RFID (38) est comprise entre 39 % et 54 %.

15. Système selon la revendication 7, dans lequel les signaux (36) ont une fréquence porteuse entre 30 et 300 kHz.

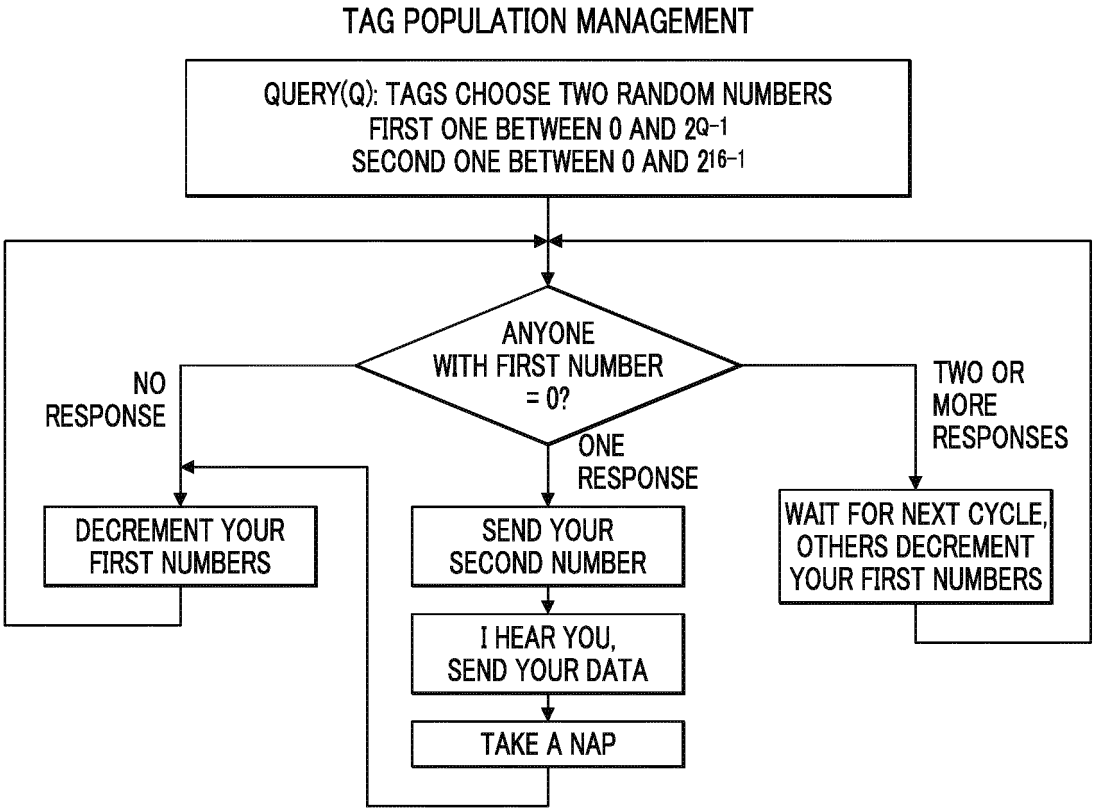
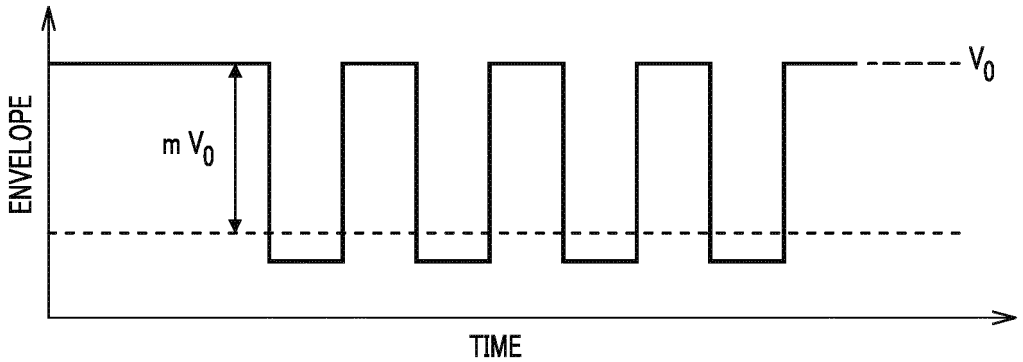


FIG. 1
PRIOR ART



MODULATED READER SIGNAL WAVEFORM (MODULATION INDEX m, 0<m<1)

FIG. 2

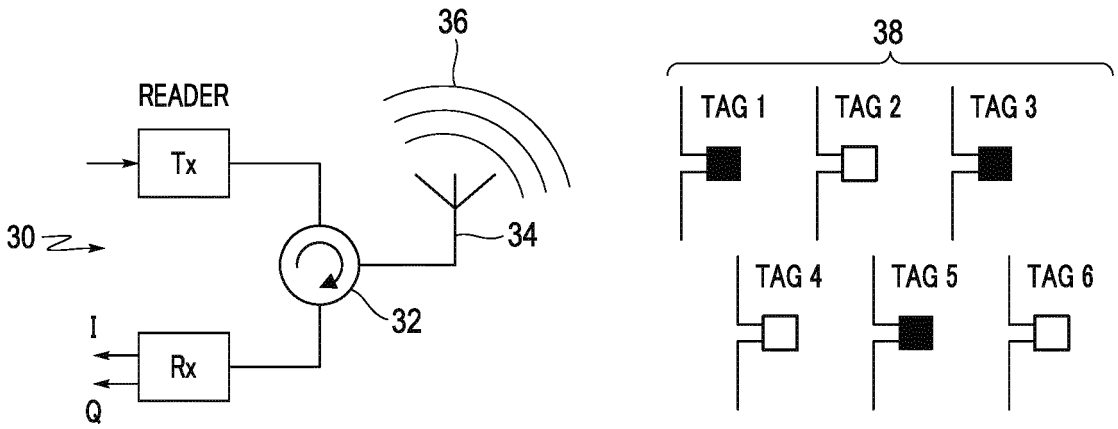

36
38
READER
Tx
30
34
32
I
Rx
Q
TAG 1
TAG 2
TAG 3
TAG 4
TAG 5
TAG 6

FIG. 3

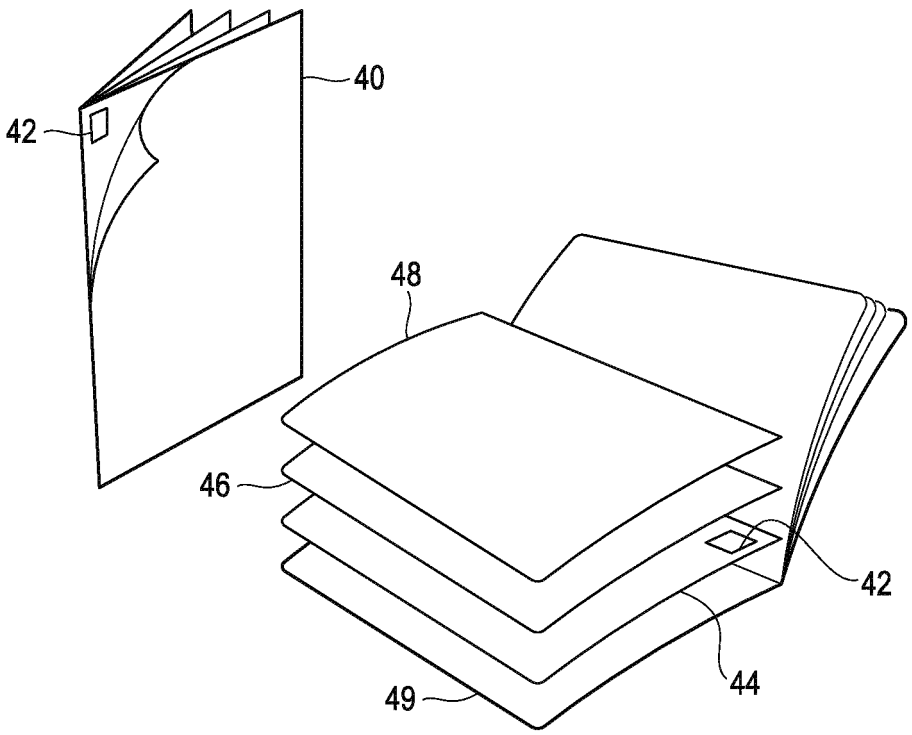

40
42
48
46
42
44
49

FIG. 4

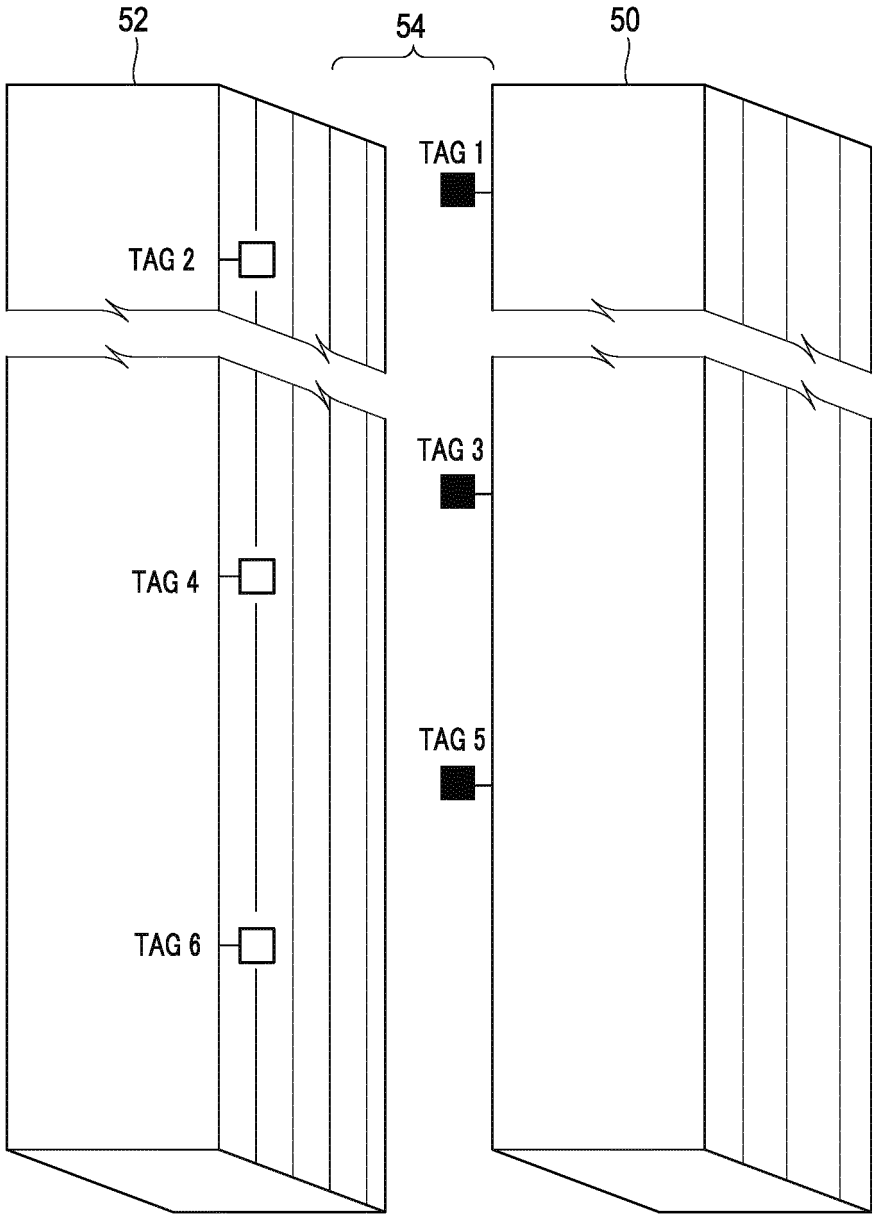


FIG. 5

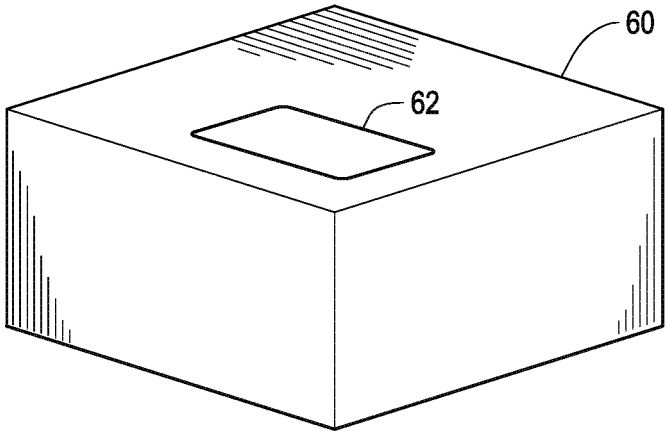

60
62

FIG. 6

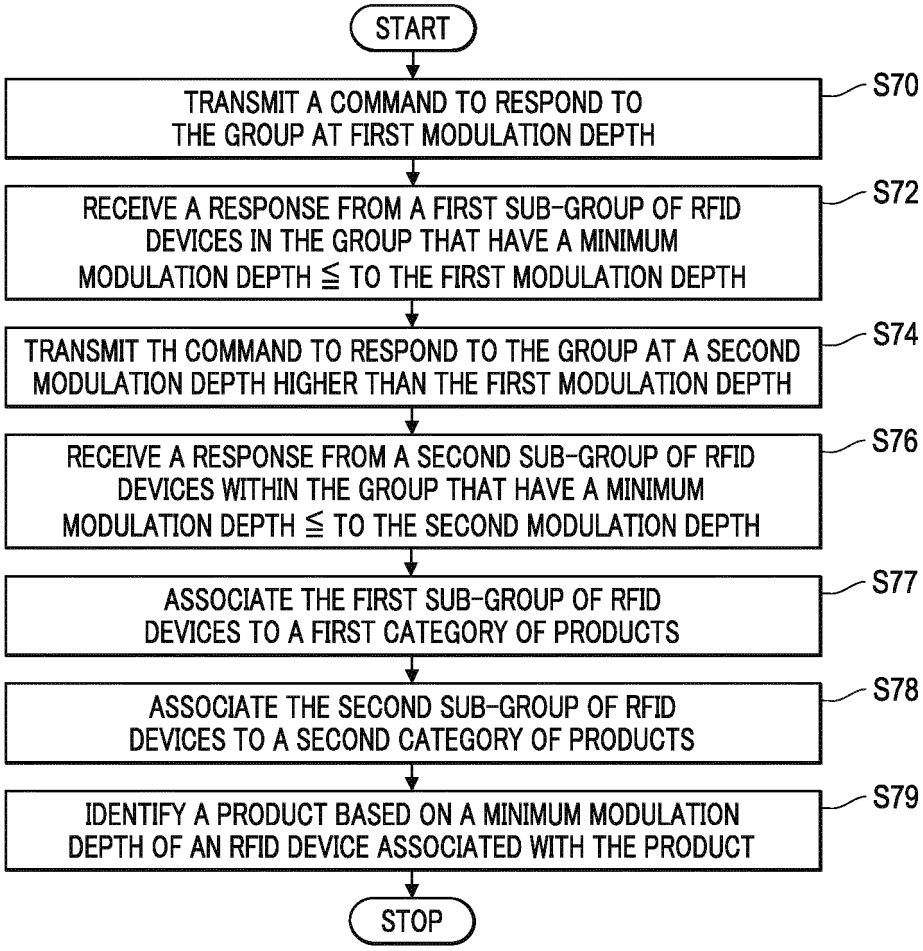

START
TRANSMIT A COMMAND TO RESPOND TO THE GROUP AT FIRST MODULATION DEPTH
S70
RECEIVE A RESPONSE FROM A FIRST SUB-GROUP OF RFID DEVICES IN THE GROUP THAT HAVE A MINIMUM MODULATION DEPTH ≦ TO THE FIRST MODULATION DEPTH
S72
TRANSMIT TH COMMAND TO RESPOND TO THE GROUP AT A SECOND MODULATION DEPTH HIGHER THAN THE FIRST MODULATION DEPTH
S74
RECEIVE A RESPONSE FROM A SECOND SUB-GROUP OF RFID DEVICES WITHIN THE GROUP THAT HAVE A MINIMUM MODULATION DEPTH ≦ TO THE SECOND MODULATION DEPTH
S76
ASSOCIATE THE FIRST SUB-GROUP OF RFID DEVICES TO A FIRST CATEGORY OF PRODUCTS
S77
ASSOCIATE THE SECOND SUB-GROUP OF RFID DEVICES TO A SECOND CATEGORY OF PRODUCTS
S78
IDENTIFY A PRODUCT BASED ON A MINIMUM MODULATION DEPTH OF AN RFID DEVICE ASSOCIATED WITH THE PRODUCT
S79
STOP

FIG. 7

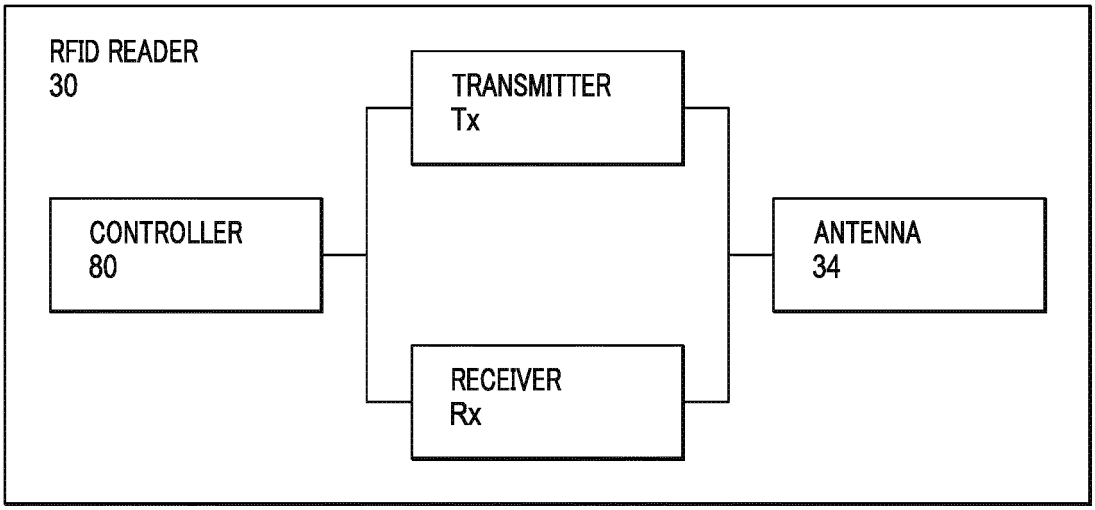

RFID READER
30
TRANSMITTER
Tx
CONTROLLER
80
ANTENNA
34
RECEIVER
Rx

FIG. 8

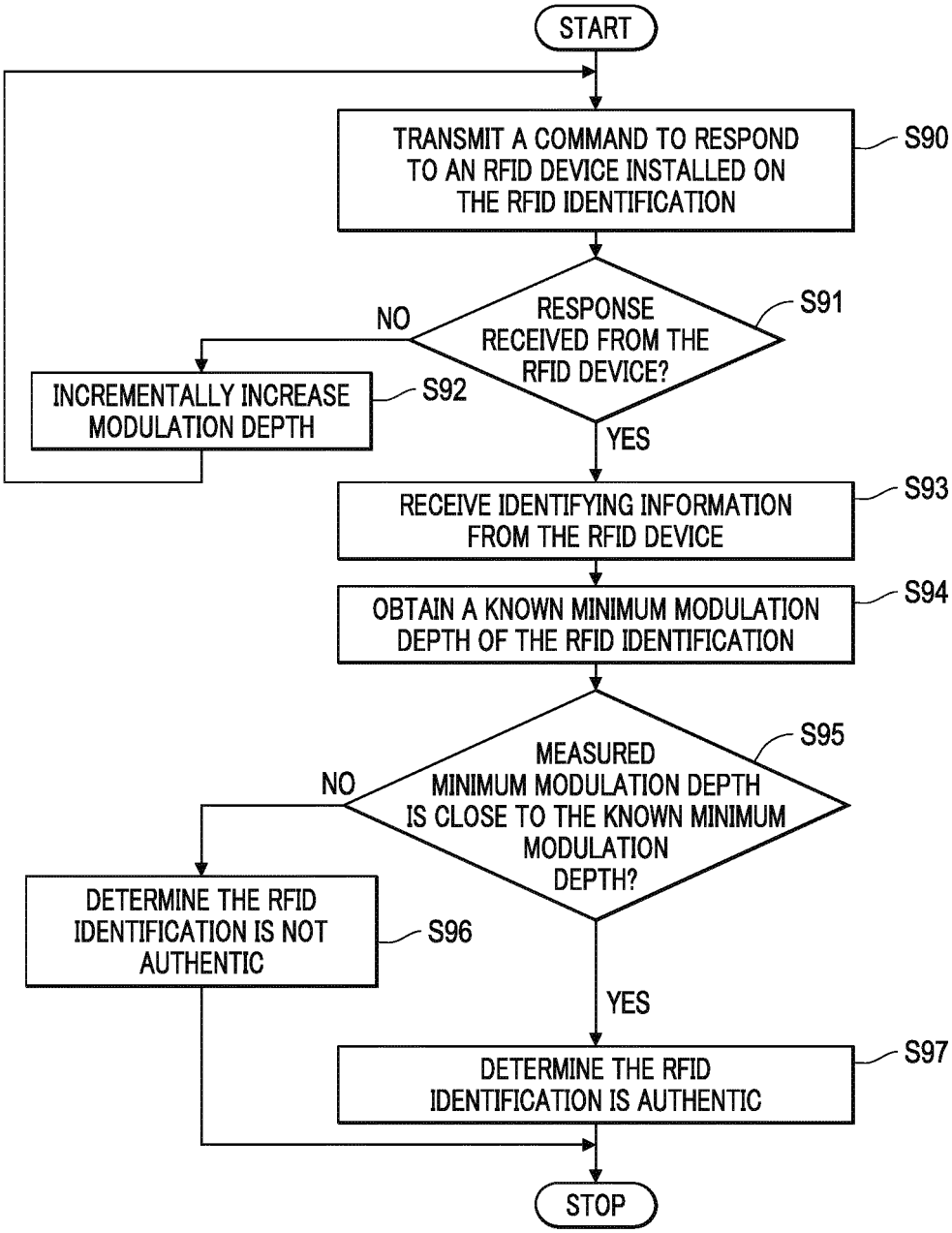

START
TRANSMIT A COMMAND TO RESPOND TO AN RFID DEVICE INSTALLED ON THE RFID IDENTIFICATION
S90
RESPONSE RECEIVED FROM THE RFID DEVICE?
S91
NO
INCREMENTALLY INCREASE MODULATION DEPTH
S92
YES
RECEIVE IDENTIFYING INFORMATION FROM THE RFID DEVICE
S93
OBTAIN A KNOWN MINIMUM MODULATION DEPTH OF THE RFID IDENTIFICATION
S94
MEASURED MINIMUM MODULATION DEPTH IS CLOSE TO THE KNOWN MINIMUM MODULATION DEPTH?
S95
NO
DETERMINE THE RFID IDENTIFICATION IS NOT AUTHENTIC
S96
YES
DETERMINE THE RFID IDENTIFICATION IS AUTHENTIC
S97
STOP

FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2011163855 A **[0006]**
- US 2013241716 A **[0006]**