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(54) **Title**: VHF/UHF MULTIFUNCTION SENSOR

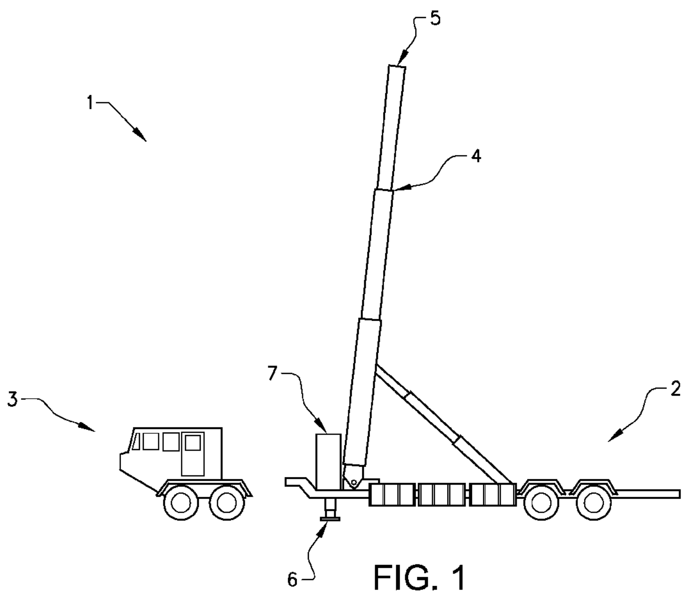


FIG. 1

**(57) Abstract**: The invention relates to an RF sensor (1) for mounting on a self-propelled vehicle or a trailer (2), comprising an erectable antenna mount (4) capable of rotating 360°, said erectable antenna mount being capable of mounting at least one front end (8, 9, 10) comprising antenna elements, transmit/receive modules and at least one RF distribution network. The RF sensor (1) further comprising a back-end (7) comprising at least one digital waveform generator, at least two digital receiver and a Signal and Data Unit and a control computer; and the RF sensor (1) further comprising a power plant and means of communication to a command centre and to the operator. At least one front end (8, 9, 10) is capable of a radar function. The erectable antenna mount (5) comprises connection means allowing for exchanging of front ends (8, 9, 10) covering different frequency ranges, and in that the back-end (7) is arranged to cover a frequency range greater than any of the frequency ranges of the front ends (8, 9, 10). The invention further relates to a method for deploying and redeploying an RF sensor system.

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## TITLE

VHF/UHF Multifunction sensor

## TECHNICAL FIELD

The present invention relates to a radio frequency (RF) sensor for mounting on a self-propelled vehicle or a trailer, comprising an erectable antenna mount capable of rotating at least one front end 360°, said erectable antenna mount being capable of mounting at least one front end comprising antenna elements, transmit/receive modules and at least one RF distribution network; the RF sensor further comprising a back-end comprising at least one digital waveform generator, at least two digital receivers a Signal and Data Unit and a control computer; the RF sensor further comprising a power plant and means of communication; said at least one front-end antenna being capable of a radar function. The present invention also relates to a method for deploying and redeploying an RF sensor.

## BACKGROUND

Since the early 1990´s there has been a trend towards Low-Observable (LO) or stealth military aircraft. Therefore, the need for dimensioning air defence system against LO aircraft has increased. A possible consequence is that the global market of traditional ground radars at S, C, and X bands will diminish, at least to some extent. The main reason for this is that typical detection ranges of traditional radars against LO-aircraft falls short of the stand-off ranges typical for state-of-the-art air-to-ground missiles.

It is well-known that there are frequency bands where the applied LO-technologies do not work, namely the VHF, UHF and to some extent, L bands. There are no or little technological difficulties in the design and manufacturing of a VHF or UHF radar, but cost, legislative obstacles and anticipated countermeasures have delayed the introduction of such systems.

There are few allocated radar bands in the VHF/UHF part of the spectrum, rendering peace-time operation and practice difficult or even impossible. As a consequence, everyday tasks such as air space surveillance cannot be robustly executed and will not be able to bear part of the acquisition cost. Another risk is that military planners are reluctant to depend on systems that will be poorly tested and hence not fully integrated in their air defence systems.

Even if an RF system operating in the VHF/UHF frequency range that uses the legally available, narrow frequency slots, is successfully deployed, it will be very vulnerable to enemy countermeasures, since the knowledge of the operating band can be efficiently used for jamming.

VHF/UHF radars are also considered costly because of their inability to reproduce several of the advanced radar functions already present in existing inventories, e.g. target height estimation, high clutter rejection, and the detectability of low-flying targets. A VHF/UHF radar just adds to the cost, albeit providing a counter-stealth ability. Moreover, the RF components of the VHF/UHF radar are technologically disparate from existing radars at higher bands, which seemingly prohibits reuse.

Clearly, an RF sensor is needed that eliminates the problems listed above.

## SUMMARY

The present invention intends to solve the problem by providing an RF sensor disclosed in claim 1. Further, a method for deploying and redeploying an RF sensor is disclosed in independent claims 16 and 18.

An RF sensor for mounting on a self-propelled vehicle or a trailer according to one aspect of the invention, comprises an erectable antenna mount capable of rotating an antenna front-end 360° said erectable antenna mount being capable of mounting at least one front end comprising antenna elements, transmit/receive modules and at least one RF distribution network. The RF sensor further comprises a back-end comprising at least one digital waveform generator, at least two digital receivers and a Signal and Data Unit and a control computer. The RF sensor further comprises a power plant and means of communication; said at least one front-end antenna being capable of a radar function. The antenna mount comprises connection means allowing for exchanging front ends covering different frequency ranges, and the back-end is arranged to cover a frequency range greater than the frequency range of any of the front ends. The entire frequency range of the back end may be referred to as a system band.

By being able to exchange front ends the RF sensor can be adapted to work in different frequency ranges. The greater range of the back-end means that the RF sensor may have this flexibility without having to replace the back-end at the same time as the front end. The connection means for allowing the front end to be replaced are a digital interface, an RF interface, a power supply interface and a mechanical interface, which all are specified to function in the entire back-end frequency range.

The front ends may be AESA antennas. The advantages of using AESA antennas are that it is difficult to generate the required (up to 100 kW) peak power with a sufficiently wideband central transmitter, a VHF antenna with the required instrumented range (at least 200 km) will be large and difficult to scan mechanically and that the low side lobes of an RF distribution network-backed AESA may suppress a plurality of low-power emitters without having to form a large number of emitter suppressing nulls in the antenna receive pattern.

The antenna elements should be horizontally polarised, they should have an azimuthally wide active element pattern in order to maximize azimuthal scanning, and they should be able to pack densely enough to prohibit grating lobes at maximum front end frequency and maximum scan angle. The maximum scan angle should be wide, at least +/- 45°, not only because of the usual coverage requirements, but also since it is desirable to separate well the emitter from the threat sector when using the passive, bi-static radar mode.

The radar function of the RF sensor may be complemented by at least one sensor function, chosen from the following: a jammer function, a jammer designation function, a communications function, an electronic support measures function, and a passive, parasitic bistatic radar function. The possibility to add additional functions in addition to the radar function vastly increases the usefulness of the RF sensor. A jammer function enables the RF sensor to disrupt and/or block enemy radar or communication systems. A jammer designation function enables the RF sensor to find the direction of an enemy jamming source, which is particularly useful in situations when the radar function is degraded by intense jamming. A communications function enables the RF sensor to act as a mobile and geographically advanced long-range node for various communications tasks. The electronic support measures function enables the RF sensor to perform signals intelligence such as communications intelligence (COMINT), electronic intelligence (ELINT) and traffic analysis. The parasitic, bistatic radar function uses commercial and/or other radio transmitters to detect targets without generating own radar emissions.

In the following is described a frequency versatility that is facilitated by wideband digital waveform generators and receivers. The RF sensor is designed to be satisfactory operable in peace-time, i.e. to comply with international frequency allocation agreements in any region. The signal intelligence modes are passive and do not cause any frequency allocation conflicts. The bistatic radar mode offers detection of non-transmitting targets and makes it possible to practice radar operation without generating own emissions. An application band should be chosen so that it contains at least one, peace-time allocated radar band. The local frequency usage can be instantaneously surveyed in order to temporally extend the radar frequencies, e.g. during intermediary conflict states such as rescue operations, peace operations etc. The application bands may be customer-specifiable. The system is further designed to be readily adoptable to local frequency allocation plans.

The selection and usage of one or more said sensor functions is controllable digitally by means of the control computer according to pre-set or dynamically adjusted rules, by operator commands, or by remote commands sent to the RF sensor. This allows for flexibility when deploying the RF sensor as it can be equipped with the necessary functions needed for specific tasks. It may also be possible to alter the functionality of the RF sensor based on changing external factors, such as an increased threat level.

The digital receivers and wave-form generators in the back-end are capable of permitting operation in a system bandwidth exceeding what is feasible for one front-end antenna. Therefore, the RF sensor is designed to function with a variety of front ends, each covering a different frequency range. The range of the system bandwidth may be for instance from 100 MHz up to 1000 MHz covering the preferred VHF/UHF frequencies.

The transmit/receive modules of the at least one front end comprise at least two parallel receive chains, thus enabling the passive, parasitic bistatic radar function. One of the parallel receive chains receives a direct radio signal from for instance a TV and/or radio transmitter while the other receive chain receives a radio signal from the same TV and/or radio tower that has been reflected from a target.

The receive chain that is used for forming an antenna lobe towards the target will have a low sidelobe level towards the TV and/or radio transmitter. Nevertheless, the TV and/or radio transmitter might be so strong that it induces a degradation in the said receive chain. Therefore, a number of receivers might be needed in order for the Signal and Data Unit to form a null in the direction of the TV and/or radio transmitter by means of adaptive signal processing.

The relative power received in the each receive chains is realised by a fixed hardware-determined splitting ratio and by adjustable core-chip settings. This is necessary since the dynamic range between the directly received signal and the scattered signal may be too large to handle for solid-state core-chips alone.

The working frequency of the RF sensor may be controllable digitally by the control computer within the system band.

The usage of frequencies on transmit may be controllable digitally by means of the control computer according to pre-determined or dynamically adjusted rules.

The waveforms on transmit and receive in all aspects may be controllable digitally by means of the control computer.

The RF sensor is preferably completely wave-form agile in the system band. The transmitted signals (radar, COM) is therefore preferably completely controllable (instantaneous frequency, pulse repetition rate, pulse length, pulse coding, frequency hopping, COM modulation formats etc) by means of the control computer.

In the passive, parasitic bistatic radar mode, the broadcast signal is received and if necessary restored by digital means by the control computer in order to remove deteriorating influence from delayed echoes induced by the surrounding terrain.

Since the waveform generator is digital, it is possible to provide, from the control computer, an arbitrary digital stream, which is converted in the waveform generator to a waveform with arbitrary carrier frequency, pulse form, modulation etc.

The signals from the antenna elements of the front end are added together in one or more RF distribution networks. It is possible to have a receiver including A/D conversion behind each antenna element or to have the element signals added in an RF distribution network. The RF sensor according to the present invention has a combination of the features. A low-sidelobe antenna pattern realized by an RF distribution network is simple and efficient in suppressing many, moderately strong emitters. Digital beam forming is preferred when a few strong emitters need to be suppressed. The number of receive channels is a cost driver. Based on the above it is advantageous if the aperture is divided into a number of sub-arrays of antenna elements, each associated with a receiver. A sub-array of antenna elements is connected to a receiver by means of an RF distribution network. Some of the sub-arrays may be small, and in the case when the sub-array consists only of one antenna element, it may function as a so-called guard element.

When operating in bi-static mode, there is no internally generated signal against which the target echo is to be compared. Instead, a separate receive lobe must be directed towards the transmitter, e.g. a TV mast. This means that two parallel signal paths and consequently two RF distribution networks are needed for the operation of the bi-static mode.

The antenna mount may be capable of holding more than one front end. This allows for even more flexible operation of the RF sensor as it is not necessary to exchange the front end when desiring a different frequency band.

The RF sensor may be equipped with a means of communication to a command centre. If the RF sensor is to be part of a sensor suite in an air defence system, possibly an integrated air defence system, it is advantageous if it has means for communication to a command centre. The command centre then may handle the strategical/tactical decisions regarding where to deploy and what function the RF sensor should use at any given time.

The command-centre communication means of the RF sensor may have a communication protocol that is able to transmit raw receive data as well as processed receive data. Processed data is more narrowband, and can therefore be made more jam-resistant while still admitting advanced sensor fusion to be executed in a command centre.

A method for deploying an RF sensor system comprising an RF sensor mounted to a self-propelled vehicle or a trailer towed by a towing vehicle where the sensor system comprising raisable and foldable legs, according to one aspect of the invention comprises the steps of:
- reducing the velocity of the self-propelled vehicle or trailer to zero;
- starting the power supply of the RF sensor upon a command from an operator;
- arranging the legs of the sensor system to establish ground contact, lifting the sensor system and orienting the vehicle or trailer horizontally;
- elevating the antenna mount upon a command from the operator;
- unfolding the front end upon command from the operator;
- establishing data-link connection with a command central;
- orienting front end towards the desired sector;
- starting of the RF sensor when lift and orientation of the vehicle or trailer, unfolding of the front end and establishing data-link connection sequences are complete.

The method for deploying an RF sensor system, wherein the RF sensor is mounted on a trailer, comprises the step of:
- driving the towing vehicle away from the trailer after the legs of the sensor system has started to lift the sensor system.

A method for redeploying an RF sensor system comprising an RF sensor, mounted to a self-propelled vehicle or a trailer towed by a towing vehicle where the sensor system comprising raisable and foldable legs, according to another aspect of the invention, comprises the steps of:
- stopping the RF sensor upon command from an operator;
- disconnecting the data-link connection with Command central;
- orienting front end in a direction suitable for folding;
- folding the front end upon command from the operator;
- lowering the antenna mount upon a command from the operator;
- raising the legs of the sensor system to remove ground contact thereby lowering the sensor system;
- stopping the power supply of the RF sensor upon a command from an operator;
- starting the vehicle when lowering of the vehicle or trailer, folding of the front end and disconnecting data-link connection sequences are complete.

The method for redeploying an RF sensor system, wherein the RF sensor is mounted on a trailer, comprises the step of:
- connecting the towing vehicle to the trailer after the legs of the sensor system has started to lower the sensor system.

The time from the initiation of the methods to the completion of the methods for deploying and redeploying the RF sensor is preferably less than 4 minutes. This is to enable a fast and flexible solution where the RF sensor quickly may be deployed against discovered threats and thereafter be redeployed when the threat situation has changed.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 schematically shows parts of a radio frequency sensor according to the invention;

Figure 2 schematically shows array antennas covering different frequency bands;

Figure 3 schematically shows frequency bands associated with the array antennas in figure 2;

Figure 4 schematically shows a transmit/receive module used in the invention.

DETAILED DESCRIPTION

The present invention relates to an RF sensor for mounting on a self-propelled vehicle or a trailer.

Figure 1 schematically shows parts of an RF sensor 1 according to the invention. Figure 2 schematically shows three side-projections of antenna arrays made up of antenna elements for use with the invention. In figure 1 the RF sensor 1 is mounted on a trailer 2 which is removable from a towing vehicle 3. The RF sensor 1 may also be mounted on a self-propelled vehicle (not shown). The trailer 2 and towing vehicle 3 or self-propelled vehicle may be any trailer 2 and towing vehicle 3 or self-propelled vehicle suitable for mounting an RF sensor 1. The operator sits in the vehicle and controls the sensor with a laptop, no operator cabin or special workplace is needed. The laptop is connected to the sensor by means of wireless techniques or by cable; it is important to be at a safe distance from the sensor.

The RF sensor 1 comprises an erectable antenna mount 5 capable of rotating an antenna front-end by 360°, said erectable antenna mount 5 being capable of mounting at least one front end 8, 9 and/or 10 shown in figure 2 comprising antenna elements, transmit/receive modules and at least one RF distribution network. The antenna mount is erectable by any means known in the art for erecting an object on a trailer or self-propelled vehicle. An example of a suitable means is a telescopic mast 4. The erectable antenna mount 5 comprises connection means (not shown) allowing for exchanging of front ends 8, 9 and/or 10 covering different frequency ranges. The connection means may also be adapted to hold more than one front end 8, 9 and/or 10 at the same time. The front end 8, 9, 10 is preferably foldable allowing for easier storage and a lower profile when the erectable antenna mount 5 is lowered. The folding of the front end is done according to any known technique.

The front end 8, 9, 10 may be made up of antenna elements mounted on a support structure. The antenna elements of the front end 8, 9, 10 may be any antenna element that provides with a suitable bandwidth (e.g. 2:1) and ability to scan (e.g. +/- 45 degrees in azimuth). An AESA antenna is an example of a front end made up of suitable antenna elements. The transmit/receive (T/R) module is described further below. The RF distribution network may be designed according to any known technique.

The RF sensor 1 further comprises a back-end 7 comprising at least one digital waveform generator, at least two digital receivers and a Signal and Data Unit and a control computer. The RF sensor 1 further comprises a power plant and a means of radio communication or other suitable means for communication with the operator, other units and a command centre (not shown). The trailer 2 or self-propelled vehicle further comprises raisable and foldable legs 6 for firmly positioning the trailer 2 or self-propelled vehicle on the ground. The legs 6 can be of any kind known in the art suitable for mounting on a trailer or self-propelled vehicle and are controllable by the operator.

As stated earlier, figure 2 schematically shows three side-projections of antenna arrays made up of antenna elements for use with the invention. In order to obtain a high degree of flexibility and to be able to cover a wide frequency spectrum different antenna arrays may be used. The antenna arrays of the front end 8, 9, 10 in figure 2 cover (from left to right) 8: 108-225 MHz, 9: 225-450 MHz and 10: 430-942 MHz. These three arrays may thus be used to cover the majority of the spectrum of interest for the invention. The arrays shown in figure 2 are merely meant as examples and are not to be taken to be limiting for the invention.

Figure 3 schematically shows the frequency ranges of the antenna arrays of the front end 8, 9, 10 of figure 2, herein referred to as I-III, together with the system band frequency range IV of the back-end 7. As can be seen the system band frequency range IV of the back-end 7 covers the entire frequency range of the antenna arrays in the front ends 8, 9, 10. The working frequency range of the back-end 7 may be set to correspond to the frequency range of a first selected antenna array of front end 8, 9 or 10. When a second antenna array different from the first antenna array is used the frequency range of the back-end 7 is changed to that of the second antenna array. The back-end 7 does thus not have to be replaced to ensure functionality over the entire frequency band. Figure 3 is intended to illustrate an example of a division of the spectrum. Other divisions of the spectrum 100-1000 MHz by using different arrays are conceivable depending on wanted applications and uses of the RF sensor.

Figure 4 schematically shows the layout of a T/R module 11 intended for use with the invention. The T/R module 11 comprises at least one transmit means and at least one receive means. In figure 4 the T/R module 11 comprises a first transmit means 12 and a first receive means 13 and a second receive means 14. The first transmit means 12 and the first receive means 13 is connected to a first RF distribution network. The second receive means 14 is connected to a second RF distribution network. The T/R module 11 further comprises a T/R switch or a circulator 16 connected to the first transmit means 12, the first receive means 13 and indirectly to the second receive means 14. The T/R module 11 is also connected to the antenna of the front end 8, 9, 10. A directional coupler 15 connected to the first receive means 13 and the second receive means 14 is intended to divert a small fraction of the received power to the second received means.

For bi-static radar the first receive means 13 is used to track the target and the second receive means 14 is used for the emitter.

For signals intelligence the first receive means 13 is used.

For jammer designation the second receive means 14 or the first receive means 13 is used, depending on the jamming power.

For active radar the first transmit means 12 and the first receive means 13 are used.

For jamming the first transmit means 13 and any of the receive means 13, 14 are used.

CLAIMS

1. A radio frequency (RF) sensor (1) for mounting on a self-propelled vehicle or a trailer (2), comprising an erectable antenna mount (5) capable of rotating at least one front end (8, 9, 10) 360°, said erectable antenna mount (5) being capable of mounting at least one front end (8, 9, 10) comprising antenna elements, transmit/receive modules and at least one RF distribution network; the RF sensor (1) further comprising a back-end (7) comprising at least one digital waveform generator, at least two digital receivers and a Signal and Data Unit and a control computer; the RF sensor (1) further comprising a power plant; said at least one front end (5) being capable of a radar function, **characterized in** that the erectable antenna mount (5) comprises connection means allowing for exchanging of front ends (8, 9, 10) covering different frequency ranges, and in that the back-end (7) is arranged to cover a frequency range greater than the frequency range of any of the front ends (8, 9, 10).

2. An RF sensor (1) according to claim 1, **characterized in** that any of the front ends (8, 9, 10) are AESA antennas.

3. An RF sensor (1) according to claim 1 or 2, **characterized in** that the radar function of the RF sensor (1) is complemented by at least one sensor function, chosen from the following: a jamming function, a jammer designation function, a communications function, an electronic support measures function, and a passive, parasitic bistatic radar function.

4. An RF sensor (1) according to claim 3, **characterized in** that the selection and usage of sensor functions is controllable digitally by means of the control computer according to pre-set or dynamically adjusted rules, by operator commands, or by remote commands sent to the RF sensor (1).

5. An RF sensor (1) according to any of claims 1-4, **characterized in** that the digital receivers and wave-form generators in the back-end (7) are capable of

permitting operation in a system bandwidth exceeding what is feasible for any of the front ends (8, 9, 10).

6. An RF sensor (1) according to claim 5, **characterized in** that the range of the system bandwidth is from 100 MHz up to 1000 MHz.

7. An RF sensor according to any of claims 1-6, **characterized in** that the T/R modules (11) of at least one front end comprise at least two parallell receive chains.

8. An RF sensor (1) according to claim 7, **characterized in** that the relative power received in the each receive chains is realised by a fixed hardware-determined splitting ratio and by adjustable core-chip settings.

9. An RF sensor (1) according to any of the preceding claims, **characterized in** that the working frequency of RF sensor is controllable digitally by the control computer within the system band IV.

10. An RF sensor (1) according to claim 9, **characterized in** that the usage of frequencies on transmit is controllable digitally by means of the control computer according to pre-determined or dynamically adjusted rules.

11. An RF sensor (1) according to any of the preceding claims, **characterized in** that the waveforms on transmit and receive in all aspects are controllable digitally by means of the control computer.

12. An RF sensor (1) according to any of the preceding claims, **characterized in** that the signals to and from the antenna elements of the front end (8, 9, 10) are added together in one or more RF distribution networks.

13. An RF sensor (1) according to any of the preceding claims, **characterized in** that the erectable antenna mount (5) is capable of holding more than one front end (8, 9, 10).

14. An RF sensor (1) according to any of the preceding claims, **characterized in** that it is equipped with means of communication to a command centre and to the operator.

15. An RF sensor (1) according to claim 14, **characterized in** that the communication protocol is able to transmit raw receive data as well as processed receive data.

16. Method for deploying an RF sensor system comprising an RF sensor (1) according to any of the previous claims mounted to a self-propelled vehicle or a trailer (2) towed by a towing vehicle (3), said self-propelled vehicle or trailer comprising raisable and foldable legs (6), **characterized in** that the operator controls the deploying by means of wireless communication with the sensor system, that the time from the initiation of the method to the completion of the method is less than 4 minutes and that the method comprises the steps of:
- reducing the velocity of the self-propelled vehicle or trailer (2) to zero;
- starting the power supply of the RF sensor (1) upon a command from an operator;
- arranging the legs (6) of the sensor system to establish ground contact, lifting the sensor system and orienting the vehicle or trailer (2) horizontally;
- elevating the erectable antenna mount (5) upon a command from the operator;
- unfolding the front end (8, 9, 10) upon command from the operator;
- establishing data-link connection with Command central;
- orienting the front end (8, 9, 10) towards a desired sector;
- starting of the RF sensor (1) when lift and orientation of the vehicle or trailer (2), unfolding of the front end (8, 9, 10) and establishing data-link connection sequences are complete.

17. Method for redeploying an RF sensor system comprising an RF sensor (1) according to any of the claims 1-15, mounted to a self-propelled vehicle or a trailer (2) towed by a towing vehicle (3), said self-propelled vehicle or trailer comprising raisable and foldable legs (6), **characterized in** that the operator controls the deploying by means of wireless communication with the sensor system, that the time from the initiation of the method to the completion of the method is less than 4 minutes and that the method comprises the steps of:

- stopping the RF sensor (1) upon command from an operator;
- disconnecting the data-link connection with Command central;
- orienting the front end (8, 9, 10) for folding;
- folding the front end (8, 9, 10) upon command from the operator;
- lowering the erectable antenna mount (5) upon a command from the operator;
- raising the legs (6) of the sensor system to remove ground contact thereby lowering the sensor system;
- stopping the power supply of the RF sensor (1) upon a command from an operator;
- starting the vehicle when lowering of the vehicle or trailer (2), folding of the front end (8, 9, 10) and disconnecting data-link connection sequences are complete.

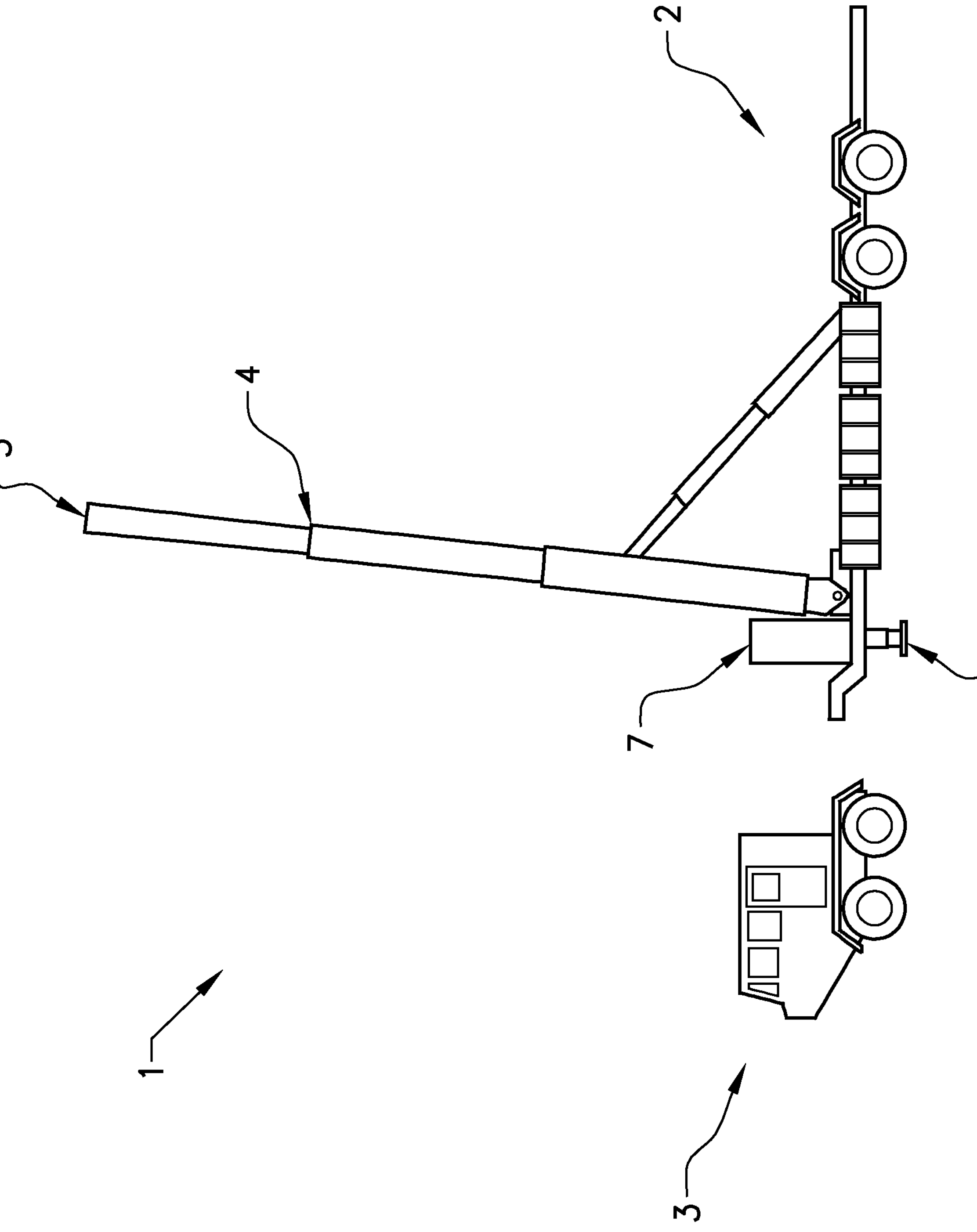


FIG. 1

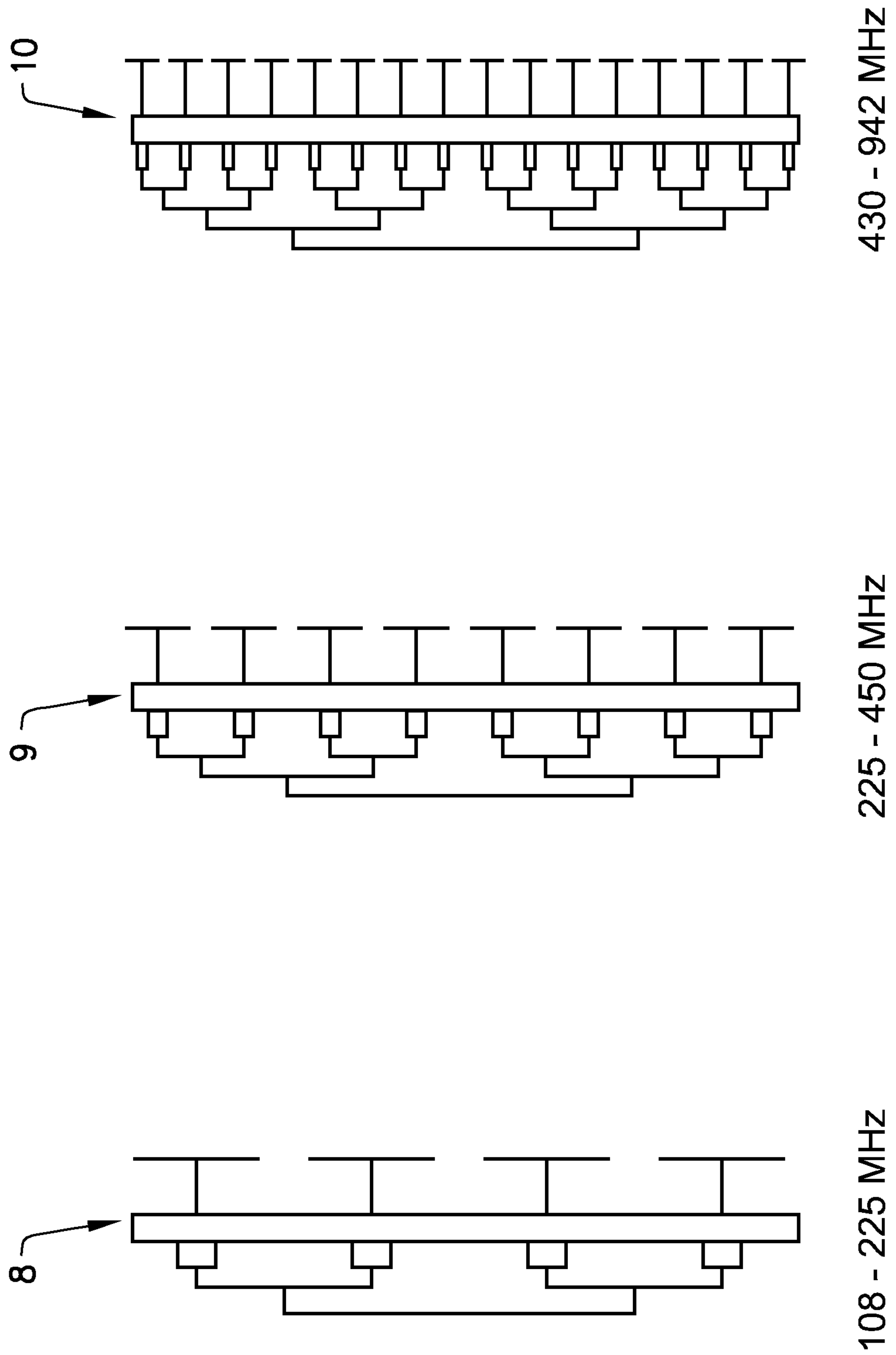


FIG. 2

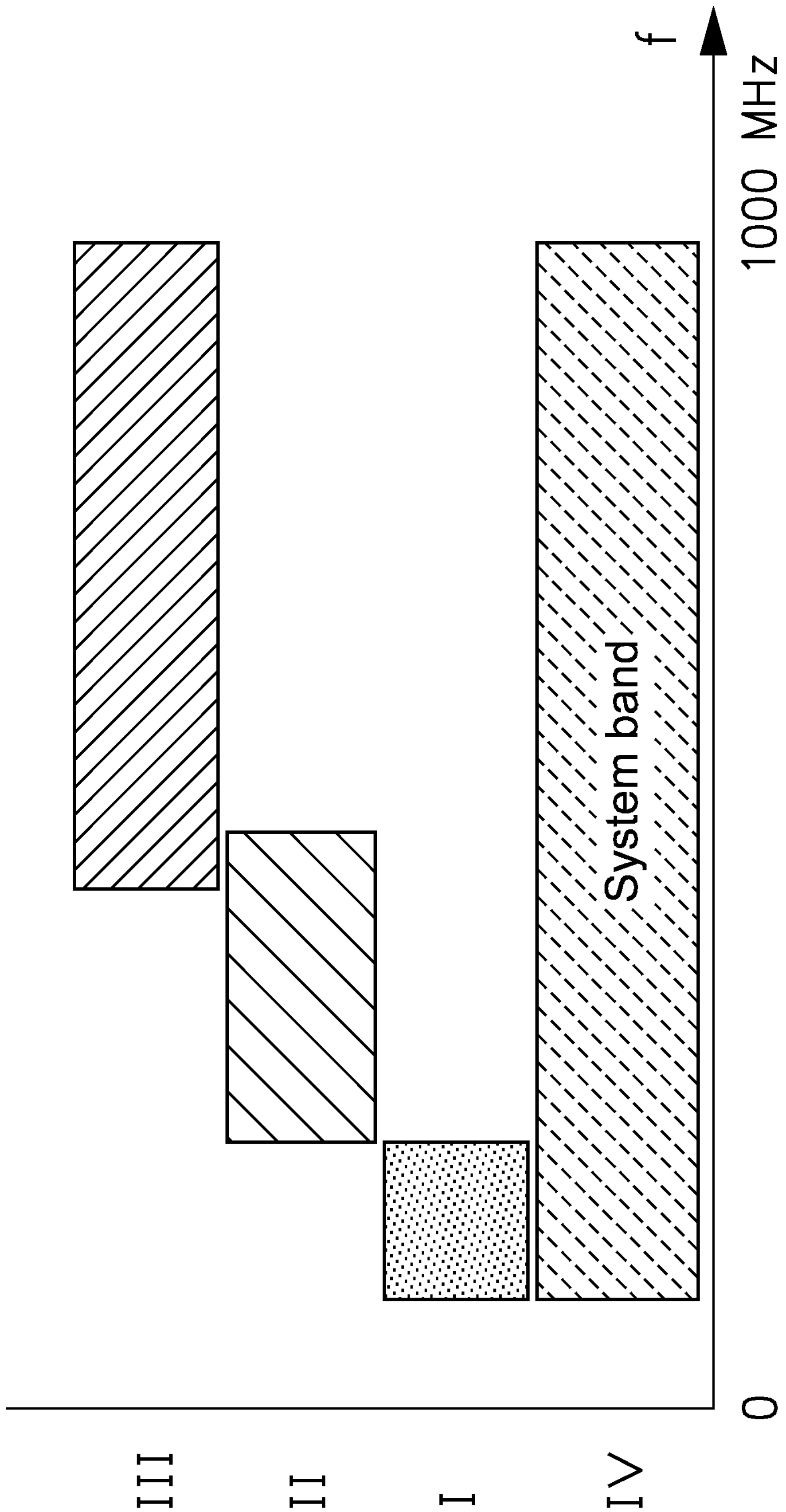


FIG. 3

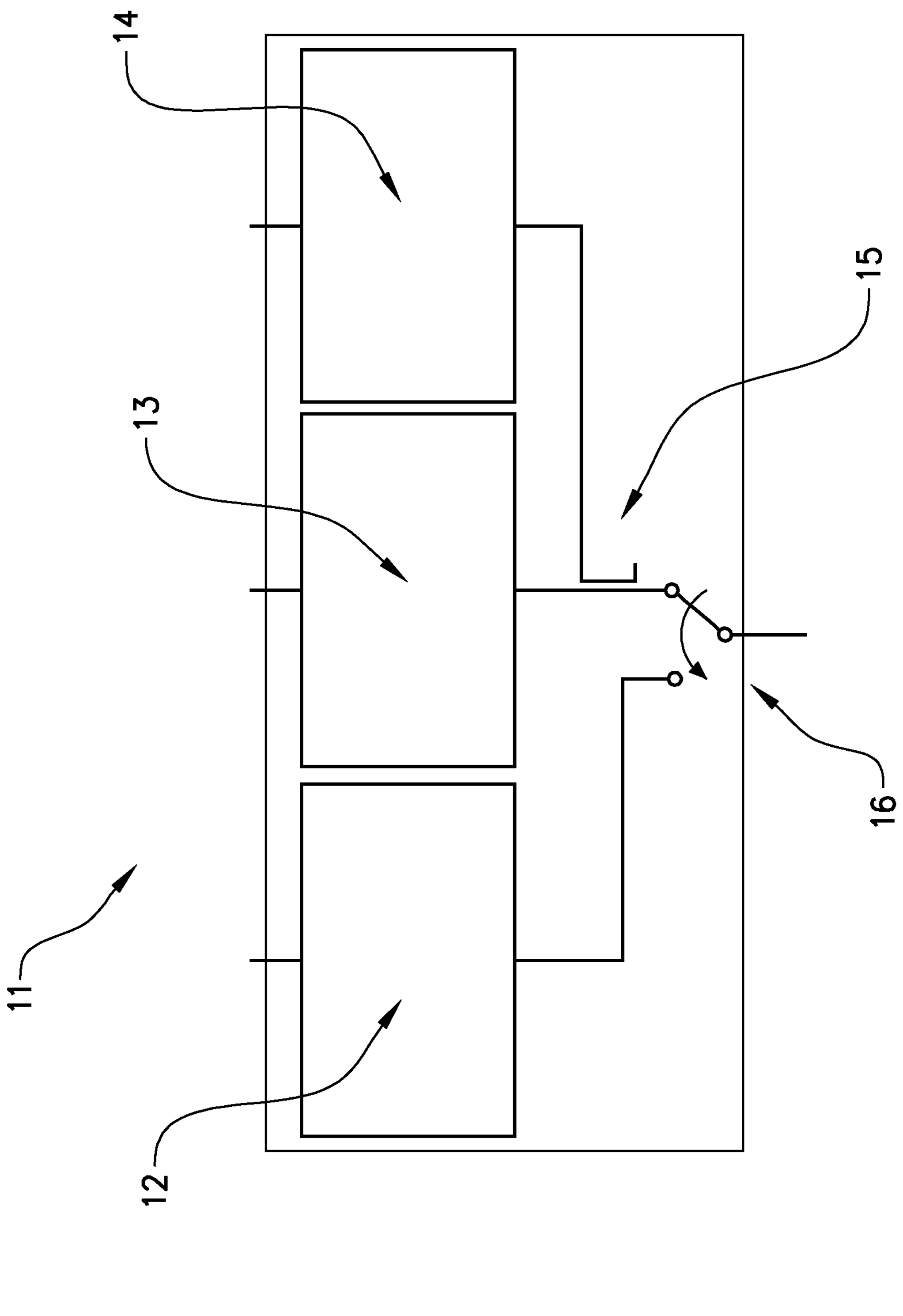


FIG. 4

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/050245

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: G01S, H01Q

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 20110012776 A1 (BARRICK DONALD E ET AL), 20 January 2011 (2011-01-20); abstract; figure 4 -- | 1-17 |
| A | DE 3416922 A1 (THEISSEN FASSADEN UND MASCHINE), 14 November 1985 (1985-11-14); abstract; figures 1,2 -- | 1-17 |
| A | US 7000357 B1 (STEARNS CRAIG KIMBAL ET AL), 21 February 2006 (2006-02-21); abstract; figures 1,2 -- | 1-17 |
| A | EP 2081252 A2 (RAYTHEON CO), 22 July 2009 (2009-07-22); abstract; paragraph [0002]; figure 1 -- -------- | 2 |

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| Patent- och registreringsverket<br>Box 5055<br>S-102 42 STOCKHOLM<br>Facsimile No. + 46 8 666 02 86 | Rune Bengtsson<br>Telephone No. + 46 8 782 25 00 |

**Continuation of:** second sheet

**International Patent Classification (IPC)**

***H01Q 1/32*** (2006.01)
***G01S 13/02*** (2006.01)
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