



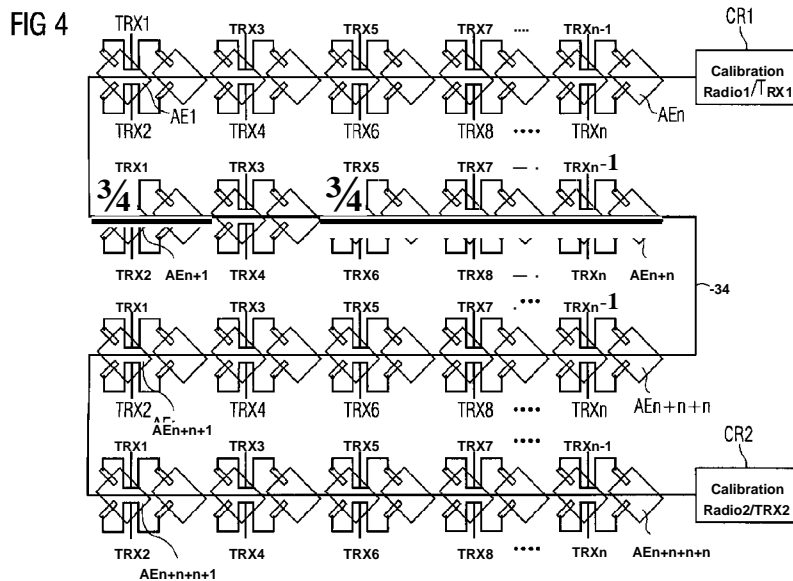
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(54) **Title:** ANTENNA ARRANGEMENT



(57) **Abstract:** An antenna arrangement is provided, which includes first and second antenna elements. A feeder line connects the first and second antenna elements for feeding a signal to and from the first and second antenna elements and the signal is inductively coupled between the feeder line and a calibration line so it can be fed to measurement equipment.

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ANTENNA ARRANGEMENT

FIELD OF THE INVENTION

5

The invention generally relates to an antenna arrangement. More particularly, the invention relates to an antenna arrangement that allows amplitude and phase detection for calibrating a re-configurable active antenna.

10

BACKGROUND OF THE INVENTION

Re-configurable active antennas are used in phased array antenna systems of mobile network base stations. In order to be able to use re-configurable active antennas for changing and maintaining the beam shape of such phased array antenna systems, it is required to calibrate the antennas and the radios. The calibration is required in order to determine the phase, amplitude and latency of the signals being transmitted and received from the transceiver and receiver, respectively, and then beam-forming of the antenna system is performed by adjusting the relative phase, amplitude and latency of the actual signals at the antenna elements or sub-arrays to which the transceiver or receiver is connected.

25

This means that the heart of the re-configurable active antenna system is the calibration system. In the past, the calibration system has been arranged as a directional coupler calibration network or an RF switch selectable network, for example. However, a directional coupler calibration network requires that every antenna element or sub-array requires a separate calibration network to be built for it, which is ex-

30

tremely complex and costly in terms of manufacture the amount of material used.

5 These problems have been solved in the past by using a probe antenna for calibration with a quarto-pole (4 arms monopole - 2 arms dipole, which is cross-polarised) coupling over the air in close field of the elements, instead of a directional coupler calibration network. However, a problem with this probe antenna design is that signal levels are sometimes very
10 small, or vary due the close field affects, that the error margin becomes unacceptable for measurement. Environmental conditions (e.g. rain, vibration or metallic objects located close by) are also known to cause error in signal coupling in this type of construction. Furthermore, in the working frequency band, the signal level can change by more than 10dB.
15

Therefore an antenna arrangement is required that can be used for calibration, without disturbing the actual functionality of the antenna, and which is robust and reliable, giving a
20 reduced error in measurements.

SUMMARY OF THE INVENTION

25 Accordingly, the invention provides an antenna arrangement. The antenna arrangement includes an antenna element and a feeder line configured to feed a signal to and from the antenna element. A calibration line is arranged proximal to and spaced apart from the feeder line and is configured to
30 receive the signal fed to and from the antenna element from the feeder line via inductive coupling. The feeder line can also receive the signal from the calibration line via inductive coupling. In other words, the feeder line and the calibration line form an inductor pair, with inductive coupling

in the inductor pair taking place from the feeder line to the calibration line, and vice versa.

Due to the arrangement of the inductive coupler pair relative
5 to the antenna element, interference is minimised. Therefore
this antenna arrangement is very reliable, providing stable,
high and consistent signal levels at all working frequencies,
and the error in measurement is reduced. Furthermore, the
antenna arrangement is very robust and does not change its
10 behaviour dependent on changes to its associated base sta-
tion, such as a change in weather conditions or adding more
antennas close to the antenna arrangement.

The calibration line should be spaced apart from the feeder
15 line by a dielectric material, for example air or an insulat-
ing material forming a base in or on which the feeder line
and calibration line are provided.

Preferably, the calibration line is configured so that it can
20 be connected directly or coupled to measurement or calibra-
tion equipment, for example a calibration radio.

In order to increase coupling between the feeder line and the
calibration line, for example in cases where it is not prac-
25 tical to position the calibration in a desired proximity to
the feeder line, an inductive coupler element may be posi-
tioned between the feeder line and the calibration line.
This inductive coupler element can simply be provided in the
calibration line, as a part of the calibration line which in-
30 dents towards the feeder line.

An additional antenna element may be provided in the antenna
arrangement so that two antenna elements are arranged as
first and second antenna elements of an antenna element pair.

In this case, the feeder line can be configured to feed the signal to both the first and second antenna elements in the pair .

5 Then the inductive coupler can be arranged so as to be symmetric about a junction point at which the feeder line divides into first and second branches leading towards the first and second antenna elements, respectively.

10 Preferably, in case of connecting two antenna elements to a same feeder line, the first and second branches of the feeder line are substantially of equal length. This generates maximum isolation between the antenna elements, as well as minimizing phase- and amplitude shift between the antenna elements,
15 when two antenna elements are connected to the same feeder line.

Furthermore, when two antenna elements are sharing same feeder line, the trace width of the two lines should be thinner
20 after the junction where the feeder line splits into two branches than with a single trace, for producing an equal 50 Ohm matching load to the single branch feeder line. This is to minimize signal loss and reflections when splitting the TX signal in half to each antenna element, or combining the RX
25 signals together from the two antenna elements.

The antenna arrangement may also be provided with a connector element, which is configured to connect to a corresponding connector element provided on another antenna arrangement.
30 In this way, the antenna arrangements may be electrically (and physically) connected with each other so that one calibration radio may be used for calibration of many antenna arrangements and only one calibration port has to be provided on one antenna arrangement for connection to the calibration

radio. This means that the antenna arrangements may be cascaded, either in a row or in columns, so that the shape of the beam forming of active antenna elements can be easily manipulated and tailored to requirements.

5

The cascaded antenna arrangements can then form an infinite (matched/terminated) coupler line coupling to/from 1-X number of antenna elements equally.

10 The connector element may be an RF coupler, e.g. a simple commercial RF coupler.

In one embodiment of the invention, the antenna element is mounted on a base and the connector element is provided on
15 the base. In this case, the feeder line and the calibration line can be provided in the base, either in a common plane with each other, or with the calibration line running underneath or above the feeder line. The base may be a printed circuit board. However, it is preferable to use RF connectors as the connector elements, rather than to connect
20 printed circuit boards together, as printed circuit boards can be susceptible to environmental damage after 10-20 years.

The invention further provides an antenna arrangement including
25 an antenna element and a feeder line configured to feed a signal to the antenna element. Furthermore, a connector element is provided, which is configured to connect the antenna arrangement with a further antenna arrangement such that the antenna arrangements are electrically connectable and can be
30 arranged in a stack.

In this way, many antenna arrangements may be connected and cascaded with each other so that only one of the antenna arrangements is required to have a calibration port for connec-

tion to a calibration radio, in order for measurements of phase, amplitude and latency to take place.

This means that the complexity of the design and manufacture
5 is significantly reduced. Furthermore, the connector element allows the antenna arrangements to be stacked or cascaded in the same plane either vertically or horizontally so that beam forming of the active antennas may be configured and tailored in accordance with requirements.

10

The cascaded antenna arrangements may then form an infinite (matched/terminated) coupler line coupling to 1-n number of antenna elements equally.

15 Advantageously, the connector element may be a commercially available RF connector. Furthermore, the feeder line and antenna element may be mounted on or in the base, for example a printed circuit board, so that the connector element can be provided on or in the base. This allows the antenna arrange-
20 ment to be manufactured simply and at low cost, using existing manufacturing techniques.

The invention also provides a method of receiving a signal from an antenna element. The method includes inductively cou-
25 pling the signal from a feeder line supplying the signal to the antenna element to a calibration line and receiving the signal at the calibration line. The signal may then be fed from the calibration line to the measurement equipment.

30 The invention will now be described, by way of example only, with reference to specific embodiments, and to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

- Figure 1 is a simplified schematic diagram of a top view of an antenna arrangement according to an embodiment of the invention;
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- Figure 2 is a simplified schematic diagram of a top view of an array of connected antenna arrangements according to an embodiment of the invention;
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- Figure 3 is a simplified schematic diagram of a top view of an antenna arrangement according to an embodiment of the invention;
15

- Figure 4 is a simplified schematic diagram of a top view of an array of connected antenna arrangements according to an embodiment of the invention;
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- Figure 5 is a simplified schematic diagram of a top view of an antenna arrangement according to an embodiment of the invention;
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- Figure 6 is a simplified schematic diagram of a top view of an antenna arrangement according to an embodiment of the invention;
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- Figure 7 is a simplified schematic diagram of a top view of an array of an antenna arrangement according to an embodiment of the invention;
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- Figure 8 is a simplified schematic diagram of a top view of an antenna arrangement according to an embodiment of the invention; and
40

- Figure 9 is a side cross-sectional view of the antenna arrangement shown in Figure 8.

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DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

10 Figure 1 shows a top view of an antenna arrangement 10, which includes a substantially rectangular base 11 having two long edges 11a1 and 11a2 and two short edges 11b1 and 11b2, for example a printed circuit board (PCB). Two patch antenna elements 12a and 12b are mounted on the base 11 so that they
15 are spaced apart from each other and arranged substantially equidistant from the long edges 11a1 and 11a2 of the rectangular base 11. A feeder port F1 is arranged substantially centrally in the base 11 between the antenna elements 12a and 12b. The feeder port may be connected, for example by a coaxial cable, to a transceiver for supplying signals to the antenna arrangement (not shown as this is on the opposite side
20 of the antenna arrangement to the antenna elements 12a and 12b) .

25 A feeder line 13 is provided in the base 11 and connects the feeder port F1 with each of the antenna elements 12a and 12b. The feeder line 13 is coupled to the feeder port F1 and leads away from the feeder port towards one long edge 11a1 of the base 11. At a junction point J, the feeder line 13 splits
30 into two branches 13a and 13b so that the first branch 13a leads to the antenna element 12a and is coupled to the antenna element 12a and the second branch 13b leads to the antenna element 12b and is coupled to the antenna element 12b.

The branches 13a and 13b of the feeder line 13 are tapered so that the part of the branches 13a and 13b at the junction point J are narrow and they gradually widen towards the points at which they are coupled to the antenna elements 12a and 12b, respectively.

Connector ports CIA and C1B are provided on opposing short edges 11b1 and 11b2 of the base 11 and are connected by a calibration line 14. The calibration line 14 is parallel with, and in close proximity to, one long edge 11a1 of the base 11 and is arranged in the base 11 so that it is in the same plane as the feeder line 13 and its branches 13a and 13b. The connector port CIA also acts as a calibration probe and, to this end, is connectable to a calibration radio (not shown).

At a point on the calibration line 14 between the connector ports CIA and C1B, the calibration line 14 is indented inwards away from the long edge 11a1 of the base 11 towards the junction point J to form an inductive coupler 15. The indentation forming the inductive coupler 15 has three sides; two sides 15a and 15b, which are parallel with the short edges 11b1 and 11b2 of the base 11, and one side 15c, which is parallel with the long edges 11a1 and 11a2 of the base 11. The long side 15c of the inductive coupler 15 is arranged symmetrically about the junction point J of the feeder line 13 and is in close proximity to the junction point J for picking up signals from the feeder line 13, although it does not touch the feeder line 13.

Another feeder line 23 couples a second feeder port F2 to the antenna elements 12a and 12b. The second feeder port F2 is also provided in the base, spaced apart from the feeder port F1, located between the antenna elements 12a and 12b and sub-

stantially equidistant from the long edges 11a1 and 11a2 of the base. The feeder port F2 is connected via a coaxial cable to a transceiver.

5 The feeder line 23 also splits into two branches 23a and 23b at a junction point J, which lead to the first and second antenna elements 12a and 12b, respectively. A second calibration line 24 and second inductive coupler 25 are also provided proximal to the feeder line 23, which are parallel with
10 (and opposite to) and identical to the calibration line 14 and inductive coupler 15 described above. The structure and function of the arrangement including the feeder port F2, feeder line 23, calibration line 24 and inductive coupler 25 are identical to those of the arrangement including the
15 feeder port F1, feeder line 13, calibration line 14 and inductive coupler 15, except that they are proximal to the opposite long edge 11a2 of the base 11.

Connector ports C2A and C2B are provided at either end of the
20 calibration line 24 on the short edges 11b1 and 11b2, respectively, of the base 11. The connector port C2A acts as a calibration probe and is connectable to the same calibration radio as the connector port CIA (with both connector ports CIA and C2A being coupled to the calibration radio via a
25 splitter/controller), while the connector port C2B is connectable to a corresponding element on a further antenna arrangement 10.

The connector ports C1B, C2B are connectable to corresponding
30 connector ports CIA, C2A on a further antenna arrangement 10 so that the antenna arrangement 10 may be connected, both physically and electrically, in a linear manner with many other antenna arrangements 10, as shown in Figure 4, so that

the antenna arrangements 10 form a coupling line in a column and are electrically connected to each other.

The connector ports of adjacent antenna arrangements may either be directly connected with each other, as shown schematically in Figure 2, or coupled via a coaxial cable.

Only the antenna arrangement at one end of the coupling line then needs to be connected to a calibration radio. The other end of the coupling line (i.e. the connector port C1B, C2B on the antenna arrangement at the other end of the line) may be terminated by a 50 Ohm resistor. Alternatively, it may be coupled in series with another identical coupling line having an equal number of antenna arrangements. Both coupling lines would then "see" an infinite matched line, giving a flat response over wide frequency range and all signals would combine well together. Coupling the antenna arrangements 10 together in a line allows the time delay between the transmitter (s) supplying the signals to the antenna arrangements 10 and the feeder point F1 of each antenna element to be tuned vertically to form a beam and govern the superposition of signals.

The inductive coupler 15, 25 is arranged so that all its sides 15a, b, c; 25a, b, c are flat and in the same plane as the feeder line 13, 23 and the calibration line 14, 24. The feeder line 13, 23 and the calibration line 14, 24 (and thus the inductive coupler 15, 25) may all be made out of the same suitable conductive material, for example copper.

In use, a signal applied to the antenna arrangement 10 at the feeder port F1, F2 and fed to (and from) the active antenna elements 12a and 12b by the feeder line 13, 23 is picked up from the feeder line 13, 23 by the inductive coupler 15, 25,

which facilitates inductive coupling of signals both to and from the feeder line 13, 33 and calibration line 14, 24. The signal then travels along the calibration line 14, 24 to the connector port CIA, C2A; i.e., the calibration probes, and
5 the phase, amplitude and latency of the signal are measured by measurement equipment connected to the connector ports CIA, C2A.

It is found that the difference in the amplitude of the signal from the feeder port F1 to the connector port CIA, C2A
10 between applied signals having frequencies of 1.92 GHz and 2.2 GHz is about 4 dB, compared to a difference of between 7 and 9 dB for prior art antenna arrangements for the same applied frequencies. Furthermore, the phase behaviour shows
15 higher, more stable signal levels over the same frequency range compared to prior art antenna arrangements.

Figure 3 shows a second embodiment of the invention in which an antenna array A is comprised of n patch antenna elements
20 AE1-AEn mounted on a base (not shown) and coupled together between a resistor R at one end of the array A and a calibration radio CR at the other end of the array A. The antenna elements are arranged in pairs, as in the first embodiment described above, so that the antenna arrangement coupled to
25 the resistor R has a pair of antenna elements AE1 and AE2 and the antenna arrangement coupled to the calibration radio CR has a pair of antenna elements AEn-1 and AEn.

Signals are fed to each antenna element AE1-AEn by two respective transceiver ports TRX1-TRXn. A feeder line 33 couples each transceiver port TRX1-TRXn with two adjacent antenna elements so that the antenna elements AE1 and AE2 are
30 both coupled to transceiver ports TRX1 and TRX2 and antenna

elements AEn-1 and AEn are both coupled to TRXn-1 and TRXn, for example.

The layout of the transceiver ports TRX1-TRXn, feeder line 33
5 and antenna elements AEl-AEn is the same as that of the feeder ports F1, F2, feeder line 13, 23 and antenna elements 12, 22 according to the first embodiment described above. However, the difference between this embodiment and the previous embodiment is that only one calibration line 34 is provided, which is connected between the resistor R and the
10 calibration radio CR in the antenna array A. The calibration line 34 runs substantially down the centre of the base on which the antenna elements AEl-AEn are mounted between each pair of transceiver ports TRX1, TRX2 ... TRXn-1, TRXn.

15 No inductive coupler as such is provided in the calibration line 34. However the calibration line 34 is arranged in close proximity to the junction of where each feeder line 33 splits into branches leading to each of the antenna elements
20 of the pair. This means that signals fed between each feeder line 33 and the antenna element AEl-AEn can be inductively coupled over air between the feeder line 33 and the calibration line 34. The calibration line 34 then picks up the active antenna signals and couples them to the calibration radio CR for phase and amplitude measurement.
25

Figure 4 shows several antenna arrays A according to the second embodiment coupled together between two calibration radios CR1 and CR2 so that they are cascaded in both rows and
30 columns.

This arrangement is effectively an infinite matched/terminated coupler line coupling signals to and from the calibration line 34 and 1-n number of antenna elements

AE1-AEn. If the calibration line 34 is arranged equidistant from the transceiver ports in each transceiver port pair, this means that signals will couple equally to and from the calibration radios CR1 and CR2. However, the calibration
5 line may also be arranged on one side of the base, instead of centrally, in which case any asymmetrical coupling to CR1 and CR2 can be compensated for in calibration algorithms.

Figure 5 shows a third embodiment having a simplified arrangement in which an antenna arrangement 40 has only one antenna element 42, instead of two. RF signals are fed to the antenna element 42 from a feeder port F4 via a feeder line 41 connecting the feeder port F4 and the antenna element 42. In this embodiment a calibration line 44 is arranged proximal to
10 and spaced apart from the feeder line 41 in the same plane as the feeder line 41. The feeder line 41 has just one branch, at least a section of which is parallel to the calibration line. The calibration line 44 may be coupled to the calibration
15 line 44 of other antenna arrangements using a commercial RF coupling line. Alternatively, the antenna element 42, feeder line 41 and calibration line 44 may be mounted on a printed circuit board having connector ports for connecting to corresponding connector ports on other antenna elements. In either configuration, the antenna arrangements may be con-
20 nected together so that they are cascaded as an "infinite" coupling line, as described above.

Figure 6 shows a development of the third embodiment, in which the calibration line 44 has an inductive coupler 45 provided therein. The inductive coupler 45 is formed by-
30 curving the calibration line 44 around the feeder port F4 and feeder line 41 to facilitate inductive coupling between the calibration line 44 and the feeder line 41.

In operation, the calibration line is coupled to a calibration radio (either directly, if it is the last antenna arrangement in the cascade or via another antenna element (s)). Signals fed to the antenna element 42 through the feeder line 41 are inductively coupled to the calibration line 44 (via the inductive coupler element 45, if provided) so that the feeder line 41 and the calibration line 44 form an inductive pair. The signals received by the calibration line are then coupled to the calibration radio for measurement.

10

Figure 7 illustrates a fourth embodiment in which an antenna arrangement 50 also just has one antenna element 52 connected to a feeder port F5 by a feeder line 51, but in this case the calibration line 54 runs underneath the feeder line 51, close to the feeder line 51, instead of in the same horizontal plane, as in the previous embodiment. Furthermore, the feeder line 51 splits into two branches at a junction J. Both branches are parallel to the calibration line 54 just after they split at the junction J, before curving back towards the antenna element 52 where they recombine.

20

As with the previous embodiments, this antenna arrangement may be coupled to other antenna arrangements to form a coupler line and, ultimately, to a calibration radio. Inductive coupling of signals between the feeder line 51 and to the calibration line 54 takes place as described above.

25

Figures 8 and 9 show a fifth embodiment, in which a feeder line having two branches 61a and 61b is connected to a feeder port F6 for feeding signals to an antenna element 62. The branch of the feeder line 61a connecting the feeder port F6 is flat and arranged perpendicularly to a cylindrical branch 61b of the feeder line, which connects to the antenna element 62.

30

A calibration line has two parts 64a and 64b, which are joined by an hollow cylindrical inductive coupler element 65 arranged co-axially to the cylindrical branch 61b of the feeder line.

When signals are fed to the antenna element 62 from the feeder port F6, they are inductively coupled by the inductive coupler element 65 from the cylindrical part 61b of the feeder line to the calibration line 64a, 64b and can be fed to measurement equipment to be measured, e.g., a calibration radio for measuring amplitude, phase and latency. Signals may also be inductively coupled by the inductive coupler element 65 from the calibration line 64a, 64b to the cylindrical part of the feeder line 61b.

Although the invention has been described hereinabove with reference to specific embodiments, it is not limited to these embodiments and no doubt further alternatives will occur to the skilled person that lie within the scope of the invention as claimed.

For example, the antenna arrangements described above may be connected in a row with many other antenna arrangements either actively (using connector ports) or passively (using inductive coupling arrangements) . In addition, two or more coupled chains of antenna elements may be arranged side by side in parallel columns.

The antenna elements described above in the exemplary embodiments are patch antennas. However, any other suitable type of antenna may be used.

CLAIMS

1. An antenna arrangement, comprising:
an antenna element;
5 a feeder line configured to feed a signal to
and from the antenna element; and
a calibration line proximal to and spaced
apart from the feeder line and configured to receive the sig-
nal from the feeder line, and to transmit the signal to the
10 feeder line, via inductive coupling.
2. The antenna arrangement according to claim 1,
wherein the calibration line is configured so that it can be
coupled to measurement equipment.
15
3. The antenna arrangement according to claim 1 or
claim 2, wherein the calibration line is spaced apart from
the feeder line by a dielectric material.
- 20 4. The antenna arrangement according to any of claims
1 to 3, further comprising an inductive coupler element posi-
tioned between the feeder line and the calibration line.
- 25 5. The antenna arrangement according to claim 4,
wherein the inductive coupler element is provided in the
calibration line.
- 30 6. The antenna arrangement according to claim 4 or
claim 5, further comprising an additional antenna element so
that said antenna element and the additional antenna element
are arranged as first and second antenna elements of an an-
tenna element pair, wherein the feeder line is configured to
feed the signal to both the first and second antenna elements
in the pair.

7. The antenna element according to claim 6, wherein the inductive coupler is symmetric about a junction point at which the feeder line divides into first and second branches leading towards the first and second antenna elements, respectively.

8. The antenna arrangement according to any of claims 1 to 7, wherein the antenna element is a patch antenna.

9. The antenna arrangement according to any of claims 1 to 8, further comprising a connector element adapted to connect to a corresponding connector element provided on another antenna arrangement so that the antenna arrangements may be cascaded.

10. The antenna arrangement according to claim 9, wherein the connector element is an RF coupler.

11. The antenna arrangement according to claim 9 or claim 10, wherein the antenna element is mounted on a base and the connector element is provided on the base.

12. The antenna arrangement according to claim 11, wherein the feeder line and the calibration line are provided in the base.

13. The antenna arrangement according to any of claims 1 to 12, wherein the feeder line and the calibration line are provided in a common plane.

14. The antenna arrangement according to any of claims 11 to 13, wherein the base is a printed circuit board or a coaxial system.

5 15. The antenna arrangement according to any of claims 9 to 14, wherein the cascaded antenna arrangements form an infinite coupler line coupling to 1-n number of antenna elements equally.

10 16. An antenna arrangement comprising:
an antenna element;
a feeder line configured to feed a signal to and from the antenna element; and
a connector element configured to connect the antenna arrangement with a further antenna arrangement such
15 that the antenna arrangements are electrically connectable and can be arranged in a stack.

20 17. A method of receiving a signal from an antenna element for coupling to measurement equipment, the method comprising inductively coupling the signal from a feeder line supplying the signal to the antenna element to a calibration line, receiving the signal at the calibration line, inductively
25 coupling a signal from the calibration line to the feeder line, and receiving the signal at the feeder line.

18. The method according to claim 17, further comprising feeding the signal from the calibration line to measurement
30 equipment.

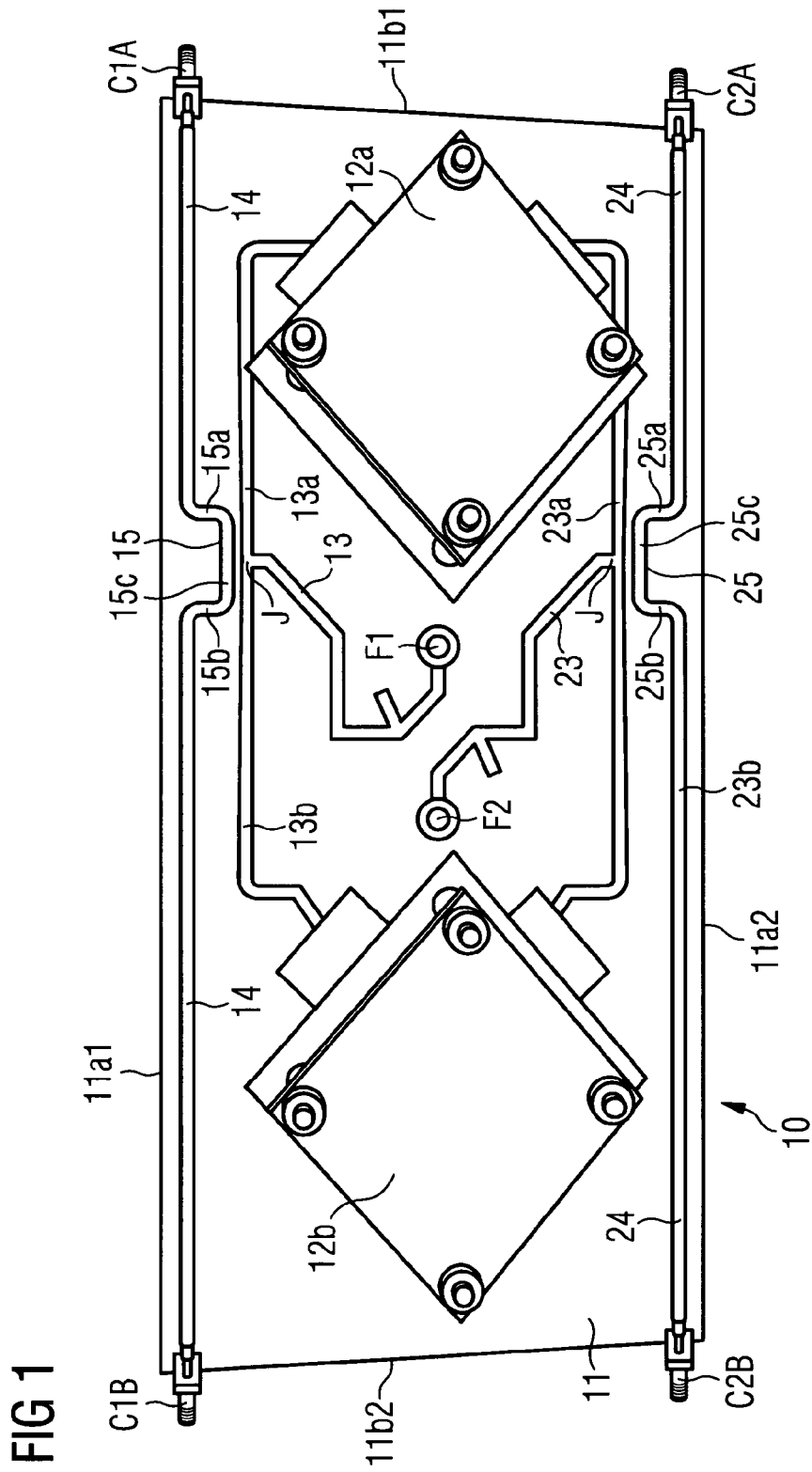
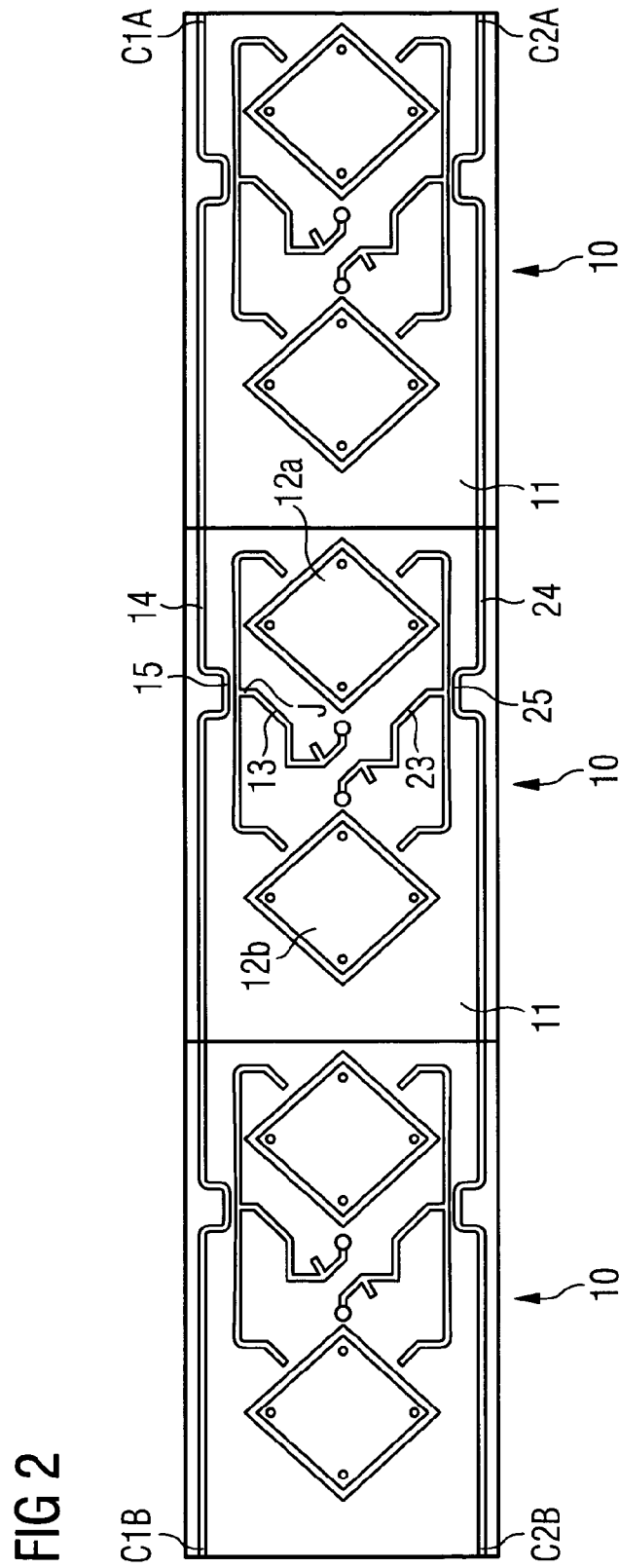


FIG 1



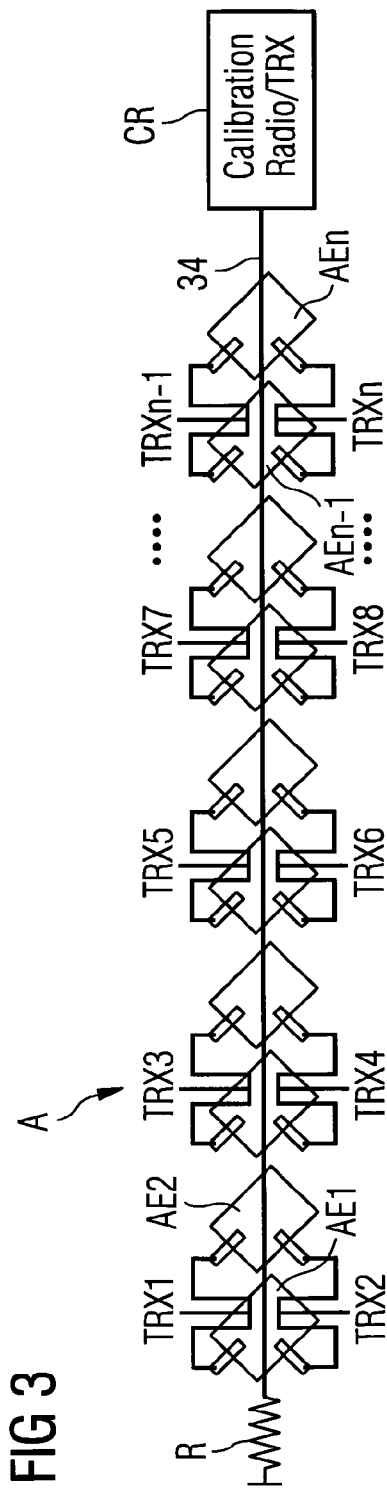


FIG 3

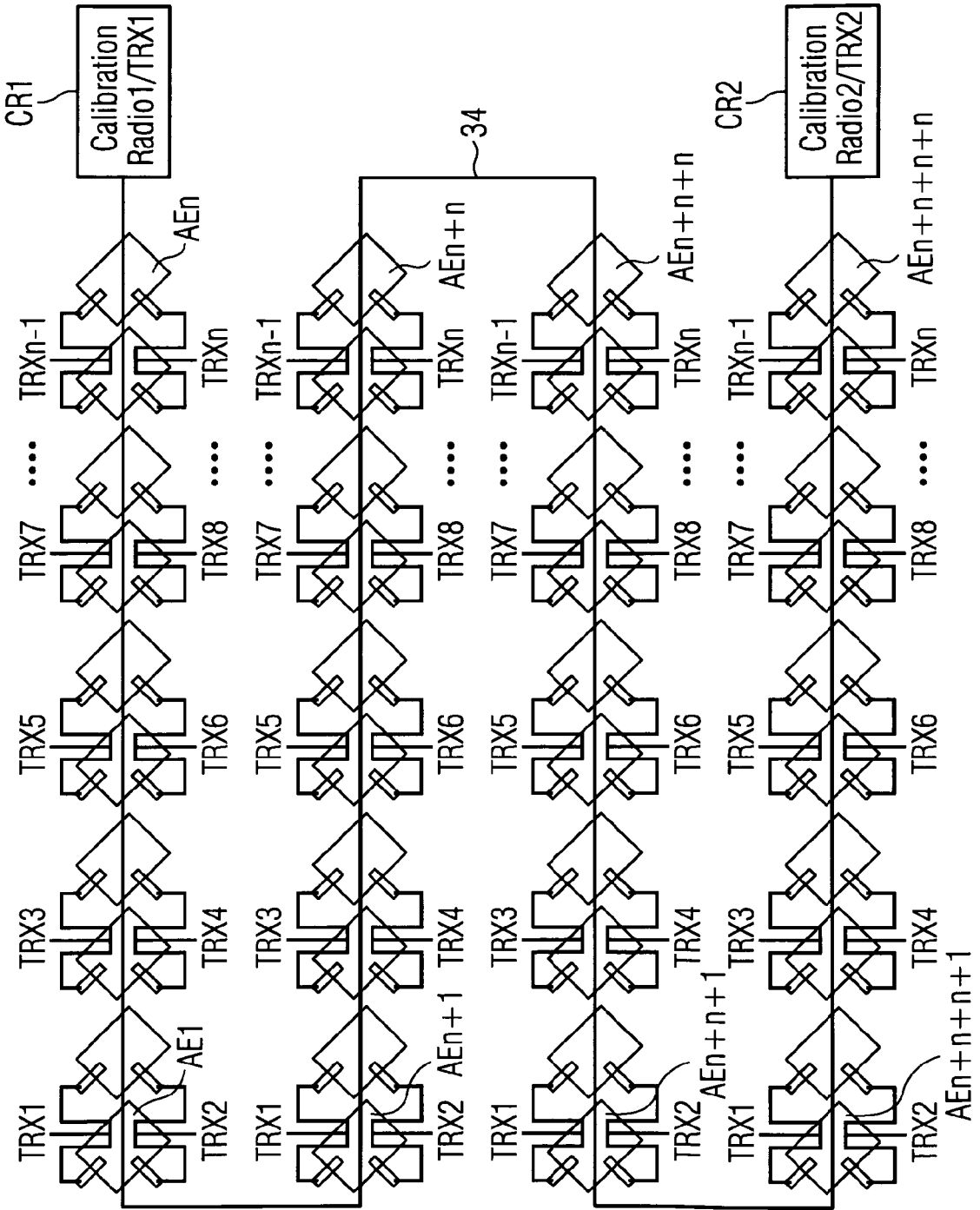


FIG 4

FIG 5

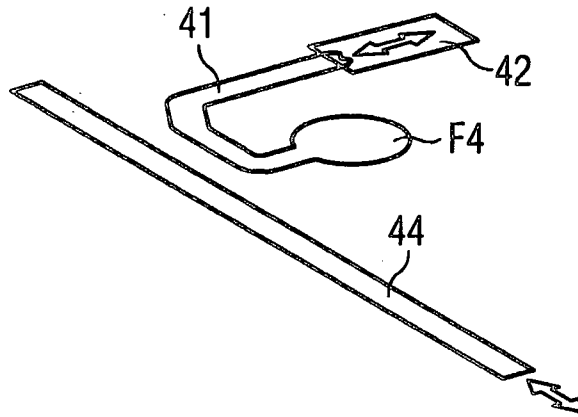


FIG 6

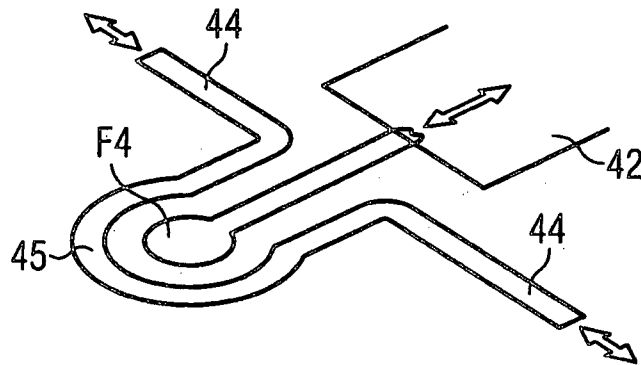


FIG 7

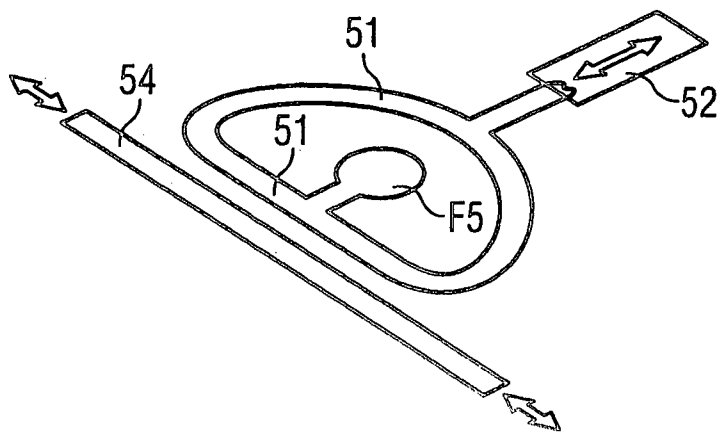


FIG 8

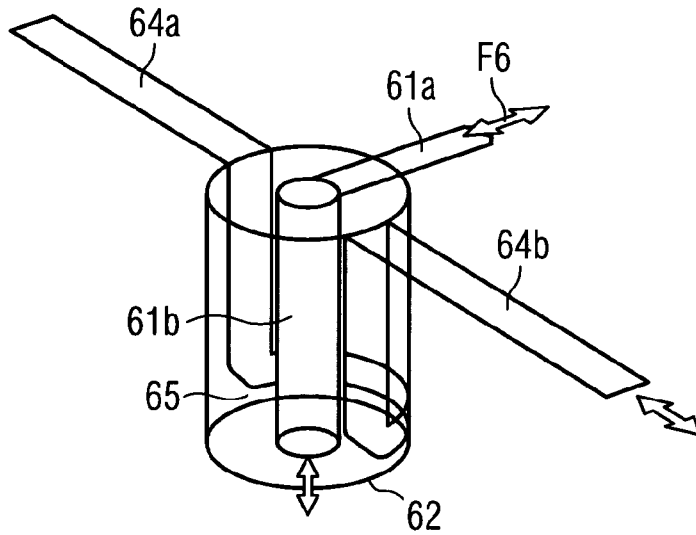
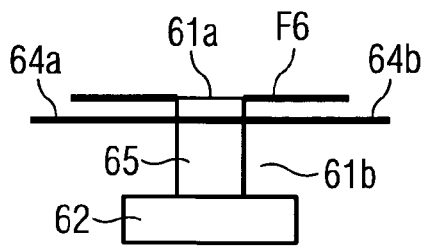


FIG 9



INTERNATIONAL SEARCH REPORT

International application No PCT/EP2010/066362
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A. CLASSIFICATION OF SUBJECT MATTER
 INV. H01Q9/04
 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)
 H01Q

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 practical, search terms used)
 EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/121948 A1 (NYSEN PAUL A [US]) 14 May 2009 (2009-05-14) abstract; figures 16c-16l paragraph [0112] - paragraph [0115] -----	1, 3-7, 9-11, 14
X	EP 1 962 374 A1 (LUCENT TECHNOLOGIES INC [US]) 27 August 2008 (2008-08-27) figure 3 paragraph [0017] - paragraph [0020] -----	1, 2
X	US 5 539 418 A (EGASHIRA SHIGERU [JP] ET AL) 23 July 1996 (1996-07-23) figure 12 column 5, line 40 - column 6, line 5 -----	1, 8, 13
A	US 2002/089447 A1 (LI SHIHE [CN]) 11 July 2002 (2002-07-11) figure 1a paragraphs [0011] - [0014], [0020] -----	1-15, 17

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 10 February 2011	Date of mailing of the international search report 06/05/2011
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Unterberger, Michael
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/ EP20 1Q/066362

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1- 15 , 17 , 18

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-15, 17, 18

An antenna arrangement comprising a feeder line and a calibration line inductively coupled to the feeder line

2. claim: 16

An antenna arrangement comprising a connector for connecting multiple antenna arrangements in a stack.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/EP2010/066362
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009121948	AI	14-05-2009	Wo 2009030045 AI 12-03-2009
			EP 2186160 AI 19-05-2010
			JP 2010538550 T 09-12-2010

EP 1962374	AI	27-08-2008	CN 101252713 A 27-08-2008
			US 2008198017 AI 21-08-2008

US 5539418	A	23-07-1996	NONE

US 2002089447	AI	11-07-2002	AT 405969 T 15-09-2008
			AU 777585 B2 21-10-2004
			AU 5519100 A 05-03-2001
			BR 0013095 A 30-04-2002
			CA 2381384 AI 15-02-2001
			Wo 0111719 AI 15-02-2001
			CN 1283901 A 14-02-2001
			EP 1204161 AI 08-05-2002
			HK 1034825 AI 21-05-2004
			JP 4392476 B2 06-01-2010
			JP 2003522445 T 22-07-2003
			MX PA02001463 A 21-07-2003
