(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 November 2006 (02.11.2006)

PCT

(10) International Publication Number
WO 2006/114749 A1

(51) International Patent Classification:
G01R 33/3415 (2006.01) *G01R 33/58* (2006.01)

(21) International Application Number:
PCT/IB2006/051251

(22) International Filing Date: 21 April 2006 (21.04.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
05103520.2 28 April 2005 (28.04.2005) EP

(71) Applicant (*for all designated States except DE, US*): **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(71) Applicant (*for DE only*): **PHILIPS INTELLECTUAL PROPERTY & STANDARDS GMBH** [DE/DE]; Steindamm 94, 20099 Hamburg (DE).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **GRAESSLIN, Ingmar** [DE/DE]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **VERNICKEL, Peter** [DE/DE]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **SCHMIDT, Joachim** [DE/DE]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **FINDEKLEE, Christian** [DE/DE]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

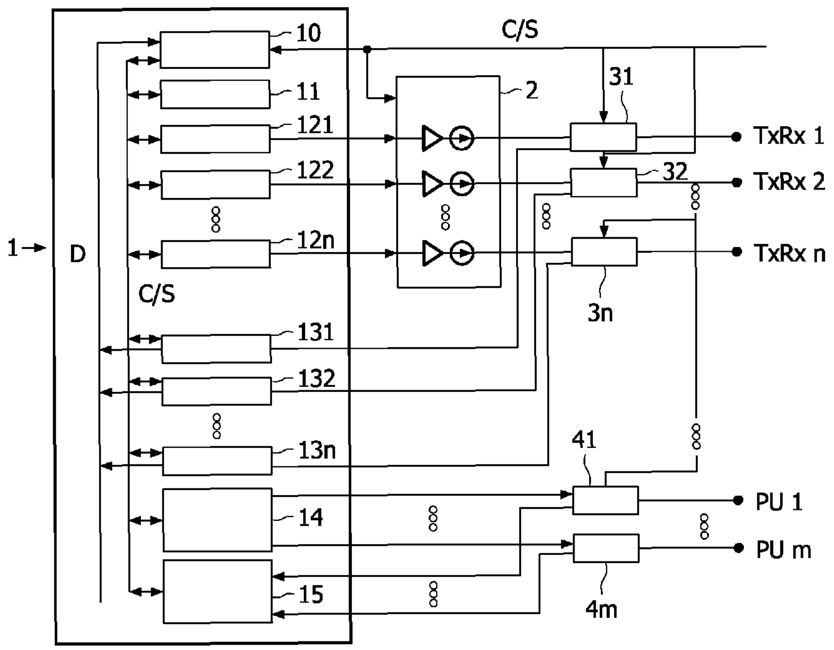
(74) Agents: **COHEN, Julius, S.** et al.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,

[Continued on next page]

(54) Title: METHOD AND CIRCUIT ARRANGEMENT FOR OPERATING MULTI-CHANNEL TRANSMIT/RECEIVE ANTENNA DEVICES



(57) Abstract: Methods and circuit arrangements for operating multi-channel transmit / receive antenna devices or arrangements especially for use in magnetic resonance imaging (MRI) systems are disclosed, by which a fully independent control of complete multi-channel RF transmit and receive chains can be conducted in a flexible way and new options like RF shimming, transmit sensitivity encoding (TransmitSENSE), RF encoding, determination of S- or Z-matrix prior to spin echo measurements, calibration, SAR (specific absorption rate) reduction etc. can be utilized or improved.

WO 2006/114749 A1

FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Method and circuit arrangement for operating multi-channel transmit/receive antenna devices

The invention relates to a method and circuit arrangement for operating a multi-channel transmit / receive antenna device or arrangement especially for use in a magnetic resonance imaging (MRI) system.

EP 1 314 995 discloses RF antenna arrangements comprising a plurality of RF coils and / or coil segments. Each one of a plurality of transmitting units is assigned to each RF coil or coil segment and provided for independently adjusting the amplitude and / or the phase and / or the shape of pulses to be transmitted. Furthermore, each one of a plurality of receiving units is assigned to each RF coil or coil segment for individually being activated or deactivated. The decoupling between the coils / coil segments of such an antenna arrangement are adjusted by means of capacitive and / or inductive elements connected between the coils / coil segments, in order to correct or tune dielectric resonance effects and / or to obtain a desired pattern of the generated field strength and to control its homogeneity.

A general object underlying the invention is to provide a method and a circuit arrangement by which such a multi-channel transmit / receive antenna device or arrangement can be operated in a more efficient manner especially in case of a larger number of antenna elements, like coils and / or coil segments (coil elements or parts).

Furthermore, a method and a circuit arrangement shall be provided by which new options and possibilities of such a multi-channel transmit / receive antenna device like e.g. RF shimming, transmit sensitivity encoding (TransmitSENSE), RF encoding, determination of S- or Z-matrix prior to spin echo measurements, calibration, SAR (specific absorption rate) reduction etc. can be utilized or improved efficiently.

Furthermore, a method and a circuit arrangement shall be provided by which a calibration / recalibration of a multi-channel transmit / receive antenna device can be conducted in a simple and quick manner.

Furthermore, a method and a circuit arrangement shall be provided by which a field distribution can be determined and monitored in transmit and receive mode.

Finally, a method and a circuit arrangement shall be provided for operating a multi-channel transmit / receive antenna device of an MR system in such a way that system components and / or a patient is efficiently protected against too high electric field strengths especially when simultaneously activating or deactivating different transmit and / or receive channels of the antenna device.

The object is solved by a method according to claim 1 and a circuit arrangement according to claim 3.

An advantage of this solution is that a transmit and / or a receive signal for each channel of the antenna device can independently and simultaneously be controlled or evaluated in a comparatively simple manner especially with respect to its amplitude and / or phase and / or frequency and / or waveform.

Furthermore, trip-levels can accurately and locally be monitored. New protection mechanisms for system components during simultaneous transmit and receive of different multi-channel elements can be realized.

Another advantage of this solution is the fact, that it is effectively applicable in magnetic resonance imaging systems applying known methods like Transmit SENSE or RF shimming for e.g. avoiding dielectric resonances in examination objects (and consequently inhomogeneous RF excitation fields) which otherwise could occur due to high or very high RF field strengths.

The subclaims disclose advantageous embodiments of the method according to claim 1 and the circuit arrangement according to claim 3, respectively.

Further details, features, and advantages of the invention become obvious from the following description of exemplary and preferred embodiments of the invention with reference to the drawings in which shows:

Fig. 1 a schematic block diagram of a circuit arrangement according to a preferred embodiment of the invention, and

Fig. 2 a more detailed block diagram of one component of the circuit arrangement according to Figure 1.

Several multi-channel transmit / receive antenna devices or arrangements which can be operated by a method and circuit arrangement according to the invention are disclosed exemplarily in the above mentioned EP 1 314 995 which is made by reference to a part of this disclosure.

Such an antenna device is especially a RF coil arrangement comprising a plurality of RF coils and / or coil segments (or elements or parts) with different sizes and / or different positions which are each connected to a transmit / receive unit or channel of a circuit arrangement according to the invention.

Figure 1 shows a schematic block diagram of a preferred embodiment of a circuit arrangement for operating a multi-channel transmit / receive antenna device, wherein the circuit arrangement is a part of a magnetic resonance imaging (MRI) system and especially of a related multi-channel data acquisition system. The circuit arrangement is exemplarily provided for operating a transmit / receive antenna arrangement comprising n coils (or coil segments) TxRx1,....TxRxn for generating a B_1 field and for receiving relaxation signals from an object to be examined.

Furthermore, a number m of pick-up coils PU1,....PUm is provided (wherein preferably m = n) for transmitting and receiving defined RF signals for e.g. calibration, monitoring and / or controlling purposes.

Alternatively, a first number of tune coils for transmitting defined RF signals and a second number of pick-up coils for receiving defined RF signals can be used, wherein the first and second number is preferably equal (e.g. m).

Substantial components of the circuit arrangement are preferably implemented in a spectrometer 1 in the form of one or more add-on circuit boards. These components are a central control or processor unit 10, a waveform control unit 11, a number n of transmit channels 121,...12n, a number n of receive channels 131,...13n, a tune-coil unit 14 and a pick-up coil detection unit 15, which are all connected to each other via a control-status bus C/S. Furthermore, the receive channels 131,...13n and the central control or processor unit 10 are connected to each other via a data bus D.

The circuit arrangement further comprises a multi-channel RF amplifier 2 (or a number n of one-channel RF amplifiers), a number n of first transmit receive switches 31,.. 3n, which are each connected with their input/output terminal to one coil or coil segment TxRx1,...TxRxn of the antenna device, and a number m of second transmit receive switches 41,...4m, which are each connected with their input/output terminal to one pick-up coil PU1,....PUm.

In case of using tune coils for transmitting RF signals and pick-up coils for receiving RF signals, the second transmit receive switches 41,...4m can be omitted.

The central control or processor unit 10 is connected with a control input of the RF amplifier 2 for controlling the same. Furthermore, the central control or processor unit

10 is connected with control inputs of the transmit receive switches 31,.. 3n; 41,...4m for independently switching these switches between transmit and receive mode.

The central control or processor unit 10 is provided for controlling the number n of transmit channels 121,…12n for independently adjusting the phases and / or amplitudes and / or frequencies of the generated RF signals, for controlling the number n of receive channels 131, ...13n and for controlling the tune-coil unit 14 and the pick-up coil detection unit 15.

The waveform control unit 11 is provided for preferably independently adjusting the waveforms or pulse shapes of the RF signals generated by the transmit channels 121,...12n in dependence of a related control signal received from the central control or processor unit 10.

The outputs of the transmit channels 121,...12n are connected with inputs of the (multi-channel) RF amplifier 2. The outputs of the RF amplifier 2 are connected with the inputs of the first transmit receive switches 31,....3n, which are provided for supplying the amplified transmit RF signals to each one coil or coil segment of the antenna device when switched by the central control or processor unit 10 into the transmit mode.

The signals, which are received by the coils or coil segments (usually relaxation signals) are routed via the first transmit receive switches 31,.. 3n after switching them into the receive mode by the central control or processor unit 10, to each one of the receive channels 131,...13n for digitalization and further processing.

The transmit / receive modes of the first and second transmit receive switches 31,.. 3n; 41,...4m can be independently controlled by the central control or processor unit 10 so that for example some coils / coil segments and / or pick-up / tune coils transmit RF signals while other coils / coil segments or pick-up coils receive RF signals. Each of the first transmit receive switches 31,...3n must be capable to route RF signals having a peak power of some kW in order to excite nuclei spins. However, this power is much less than in usual conventional single channel systems.

The tune coil unit 14 comprises a number m of outputs, which are connected via the second transmit receive switches 41,..4m in transmit mode to each one pick-up coil for transmitting defined RF signals. The RF signals, which are received by these pick-up coils are routed via the transmit receive switches 41,... 4m in the receive mode to each one input of the pick-up coil detection unit 15 for processing.

If tune coils are used for transmitting and pick-up coils are used for receiving, the second transmit receive switches 41,...4m can be omitted and the tune coils are connected with the tune coil unit 14 and the pick-up coils are connected with the pick-up coil detection unit 15.

The pick-up coil detection unit 15 is shown in more details in Figure 2. It comprises a pick-up coil controller 150, which is controlled by the central control or processor unit 10 via the control-status bus C/S for controlling the processing of the signals, which are received by the pick-up coils.

For such a processing the pick-up coil detection unit 15 further comprises for each pick-up coil according to a first alternative an RF to DC converter 151 comprising a wide band logarithmic amplifier, and a trip level comparator 152, which are both controlled by the pick-up coil controller 150.

Furthermore, a storage 153 for a preset maximum trip level in the form of a DC voltage set by the spectrometer 1 or the pick-up coil controller 150 is provided. The trip levels can preferably be preset independently and with different values in each trip level storage 153 for each pick-up coil.

According to the first alternative, the received RF signals are converted to DC signals by means of the RF to DC converters 151. The DC signals are then routed to the related trip level comparators 152, which compare the DC voltages with a preset maximum trip level, which is stored in the storage 153 in the form of a DC voltage. If for example any of the DC voltages derived from all RF pick-up coil signals exceed the preset maximum trip level, a further transmission of RF signals can be inhibited by blanking the RF amplifiers 2 in order to avoid damage of system components.

Instead of processing the received RF signals in the analog domain, it can alternatively be carried out in the digital domain (second alternative). In this case, for each pick-up coil an analog-to-digital converter 154 is provided which is controlled by the pick-up coil controller 150 and which converts the DC signal into a digital signal which is compared in the trip level comparator 152 with the preset trip level as explained above.

According to a third alternative, an analog-to-digital converter 155 together with a demodulator can be used instead of the RF to DC converter 151 in order to convert the received RF signals to digital signals by means of the so-called direct conversion principle. The digital signals are each again fed into the trip level comparators 152 for comparing the same with preset trip levels as explained above.

The alternative to be chosen depends on certain boundary conditions as well as on the prices of chips available.

By this circuit arrangement a plurality of methods for operating a multi-channel transmit receive antenna device or arrangement can advantageously be conducted. These are in particular transmitting RF signals by means of at least one of the coils / coil segments of the antenna and receiving RF signals by the same or other of these coils / coil segments and / or by at least one of the pick-up coils. Another alternative is e.g. to transmit low power RF signals by means of at least one of the tune coils (or pick-up coil(s) if no tune coils are used) and receiving RF signals by at least one of the coils / coil segments of the antenna and / or by at least one of the pick-up coils.

This is especially due to the fact that the circuit arrangement allows an individual control of each RF transmit and receive signal including simultaneous transmit and receive by means of free selectable coils and / or coil segments of the RF antenna arrangement.

Correspondingly, individual local measurements of the RF field at each coil and / or coil segment can be conducted for various functions like e.g. for calibration purposes. The S-matrix can e.g. be determined by transmitting RF signals through individual coils or coil segments of the antenna arrangement and by receiving RF signals through other, non-transmitting coils or coil segments.

Furthermore, individual measurements of the multi-channel elements (especially of the coils and / or coil segments of the antenna arrangement) can be conducted by dedicated pick-up coils (or pairs of tune coils and pick-up coils). Such individual measurements can especially be provided for an accurate local and individual monitoring of trip levels, which can be preset independently for each pick-up coil. This might be advantageous for example if a symmetrical RF transmit receive coil is used in which, however, even for the same B_1 field not all pick-up coils have completely identical values of the received signals. Especially the current amplitudes for estimating the spatial B_1 field distribution in transmit and receive modes can be determined by the pick-up coils (or pairs of tune coils and pick-up coils.

By this, new methods for protecting other MRI system components against possible damage caused by RF fields (B_1 field) and / or for SAR reduction of an examination object especially during simultaneous RF transmission (and simultaneous reception) by means of different RF coils or coil segments of the antenna arrangement can be realized. If for example any of the measured local trip levels exceed related predefined trip levels, the RF amplifier 2 of the system can be blanked.

This is especially important, if not all channels are used in transmit or receive mode because in this case special care has to be taken not to destroy any electronic components in the receive path. By assigning individual local pick-up coils (or tune coils and pick-up coils) to each coil or coil segment (or each multi-channel element), any receive path can individually be protected.

This mode can e.g. also be used for the determination of S- or Z-matrices or for other calibration purposes in which the used transmit signals need to be very low. In this case, the trip levels will be set to comparatively small values and may be different for the channels in transmit or receive states.

Furthermore, the impedance of an individual coil and / or coil segment (or multi-channel element) can be determined. Preferably, a complete transmit/receive path for each pick-up coil (or each tune and pick up coil) is provided for this purpose.

Furthermore, multiple, independent RF paths for each coil and / or coil segment or each multi-channel element are provided. These paths can be configured individually for either transmission or reception of RF signals. As a consequence, it is possible to use one or more channels for RF transmission and one or more channels for RF reception, which especially in combination with a local monitoring of trip levels as explained above, opens up new options for measurements like e.g. the determination of S- or Z-matrices for individual patients.

The central control or processor unit 10 preferably comprises a related software by which the generation of the RF signals with respect to their amplitudes and / or phases and / or waveforms and / or frequencies by means of the transmit channels 121, ...12n and the waveform control unit 11, respectively, the selection of the transmit channels 121, ...12n, as well as the selection of the receive channels 131,...13n can be controlled.
Furthermore, the trip levels and the selection of the pick-up coils (or the tune and pick-up coils) are set by the software as well. This applies also to the independent switching of the transmit receive switches 31, 32,...3n; 41, 42,...4m between transmit and receive modes.

CLAIMS:

1. Method for operating a multi-channel transmit / receive antenna device or arrangement comprising a plurality of RF antenna elements, wherein the steps of:
- selecting which of one or more of the RF antenna elements transmit RF signals and / or which of one or more of the RF antenna elements receive RF signals and / or
- controlling the amplitudes and / or the phases of the RF signals transmitted by the at least one transmitting RF antenna element individually and independently for each transmitting RF antenna element,
are conducted by controlling a plurality of transmit channels and / or receive channels which are each assigned to one of the RF antenna elements.

2. Method according to claim 1, wherein the steps of selecting and / or controlling the RF antenna elements is conducted in dependence of at least one level of RF signals which are received by means of at least one receiving RF antenna element which is positioned within the RF field generated by the antenna device or arrangement.

3. Circuit arrangement for operating a multi-channel transmit / receive antenna device or arrangement, especially for conducting a method according to claims 1 or 2, comprising a plurality of RF antenna elements (TxRx), a control unit (10), a plurality of transmit channels (121,...12n) and a plurality of receive channels (131,...13n) which are each assigned to one of the antenna elements, wherein the control unit (10) is provided for selecting antenna elements for transmitting RF signals and for selecting RF antenna elements for receiving RF signals and / or for controlling the transmit channels (121,...12n) for individually adjusting the amplitudes and / or the phases of the transmitted RF signals.

4. Circuit arrangement according to claim 3, wherein the control unit (10) is provided for said selecting of the antenna elements and / or for said controlling the transmit channels in dependence on at least one level of RF signals which are received by at least one pick-up/tune coil (PU1,...PUm) which is positioned within the RF field generated by the antenna device or arrangement.

5. Circuit arrangement according to claim 4, comprising a pick-up coil detection unit (15) for processing and comparing received RF signals with at least one trip level.

6. Circuit arrangement according to claims 3, comprising a multi-channel RF amplifier (2) or a plurality of one channel RF amplifiers which are controlled by the control unit (10) in order to individually and independently amplify the transmit signals in each transmit channel.

7. Multi-channel amplifier or spectrometer (1), especially for use in a magnetic resonance imaging system, comprising a circuit arrangement according to at least one of claims 3 to 5.

8. Magnetic resonance imaging system, comprising a circuit arrangement according to at least one of claims 3 to 6.

9. Computer program comprising computer program code means adapted to perform a method according to claim 1 or 2 when said program is run on a programmable microcomputer.

10. Computer program according to claim 9 adapted to be downloaded to a magnetic resonance imaging system according to claim 8 or one of its components when run on a computer which is connected to the internet.

11. Computer program product stored on a computer readable medium, comprising computer program code means according to claim 9.

1/1

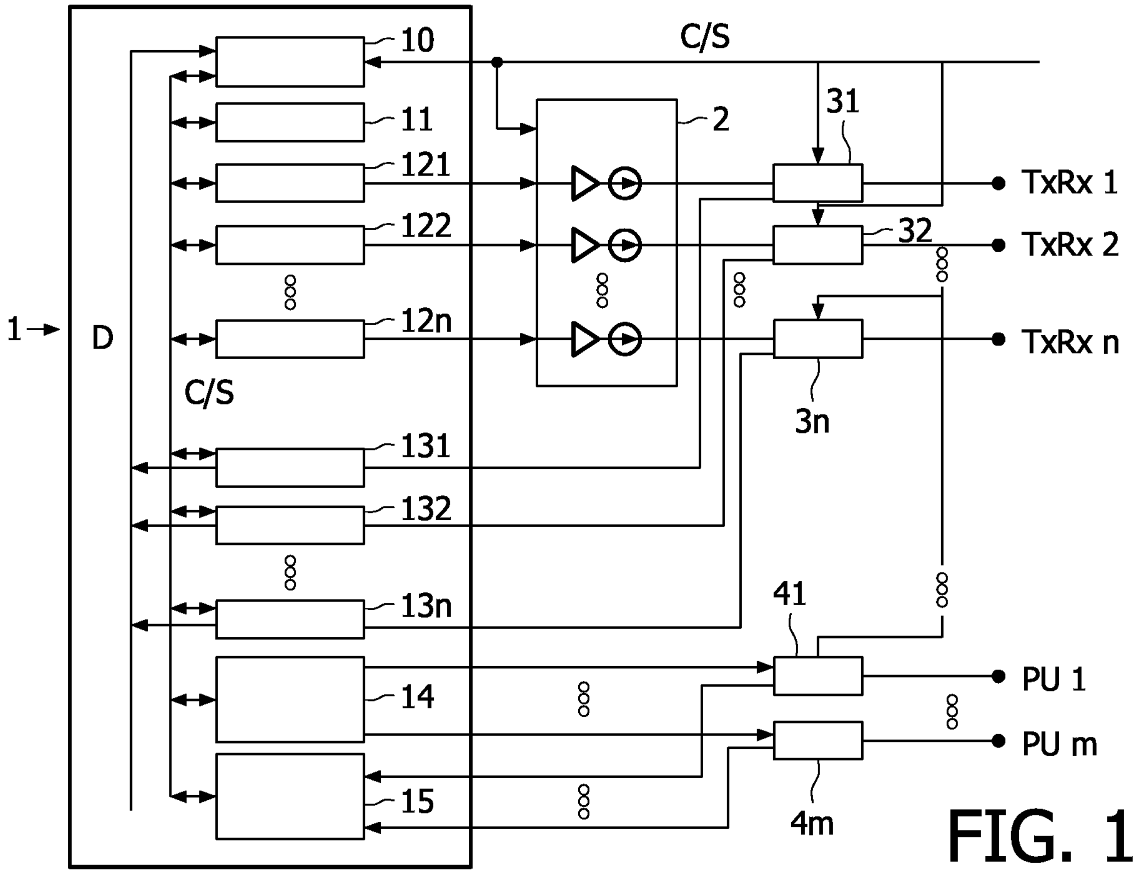

10
11
121
122
12n
1
D
C/S
131
132
13n
14
15
C/S
2
31
32
3n
TxRx 1
TxRx 2
TxRx n
41
4m
PU 1
PU m

FIG. 1

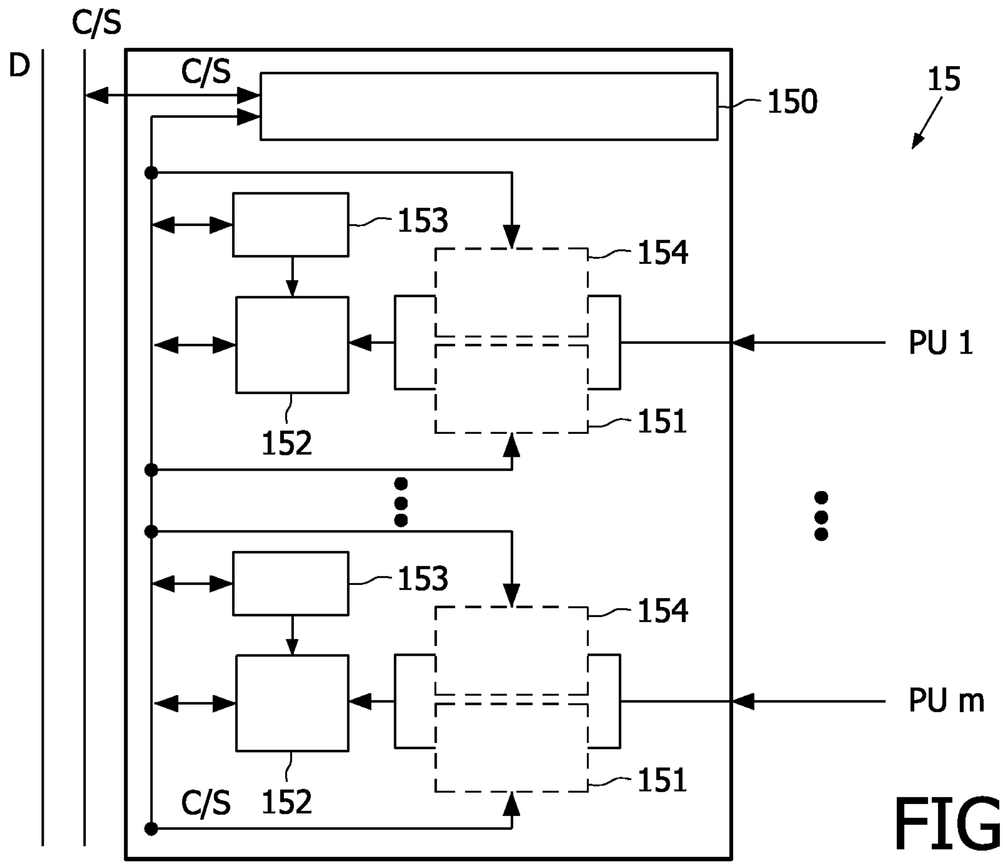

C/S
D
C/S
150
15
153
154
152
151
PU 1
153
154
PU m
C/S
152
151

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/051251

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01R33/3415 G01R33/58

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)
G01R

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, PAJ, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2004/061469 A (PHILIPS INTELLECTUAL PROPERTY & STANDARDS GMBH; KONINKLIJKE PHILIPS EL) 22 July 2004 (2004-07-22) page 2, line 5 - page 8, line 33; figure 1	1-4,6-11
Y		5
X	EP 1 314 995 A (PHILIPS INTELLECTUAL PROPERTY & STANDARDS GMBH; KONINKLIJKE PHILIPS EL) 28 May 2003 (2003-05-28) cited in the application paragraphs [0025] - [0056]; figures 2-16	1,3,6-11

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 July 2006	04/08/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lersch, W

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BOSKAMP E B ET AL: "Whole Body LPSA transceive array with optimized transmit homogeneity" PROCEEDINGS OF THE INTERNATIONAL SOCIETY FOR MAGNETIC RESONANCE IN MEDICINE. SCIENTIFIC MEETING AND EXHIBITION, vol. 10, 2002, page 903, XP002272332 conference abstract	1,3,6-11
X	US 4 682 112 A (BEER ET AL) 21 July 1987 (1987-07-21) column 3, line 16 - column 5, line 23 column 8, line 23 - column 9, line 3; figures 1-4	1-4,6-11
X	WRIGHT S M ET AL: "Theory and application of array coils in MR spectroscopy" NMR IN BIOMEDICINE, WILEY, LONDON, GB, vol. 10, no. 8, 1997, pages 394-410, XP009016838 ISSN: 0952-3480 see pages 394-401	1-4,6-11
Y	PATENT ABSTRACTS OF JAPAN vol. 017, no. 700 (C-1145), 21 December 1993 (1993-12-21) -& JP 05 237078 A (SHIMADZU CORP), 17 September 1993 (1993-09-17) abstract	5
A	US 2004/150401 A1 (EBERLER LUDWIG ET AL) 5 August 2004 (2004-08-05) paragraphs [0011] - [0017], [0023] - [0029], [0032] - [0037]; figures 1,3,4	2,4,5
A	US 2002/093336 A1 (BERNSTEIN MATTHEW A) 18 July 2002 (2002-07-18) paragraphs [0005] - [0011], [0020] - [0031]	5
A	FR 2 681 432 A (MAGNETECH) 19 March 1993 (1993-03-19) page 1, line 15 - page 6, line 19 page 8, line 24 - page 9, line 28; figure 5	2,4
A	IBRAHIM T S ET AL: "Effect of RF coil excitation on field inhomogeneity at ultra high fields: A field optimized TEM resonator" MAGNETIC RESONANCE IMAGING, TARRYTOWN, NY, US, vol. 19, no. 10, December 2001 (2001-12), pages 1339-1347, XP002385099 ISSN: 0730-725X see chapters 1, 4 and 6	1,3,6-11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2006/051251

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
WO 2004061469	A	22-07-2004	AU	2003285670	A1	29-07-2004
			CN	1735814	A	15-02-2006
			JP	2006512949	T	20-04-2006
			US	2006054810	A1	16-03-2006
EP 1314995	A	28-05-2003	DE	10157039	A1	05-06-2003
			JP	2003180659	A	02-07-2003
			US	2003122546	A1	03-07-2003
US 4682112	A	21-07-1987	DE	3535463	A1	12-06-1986
JP 05237078	A	17-09-1993	NONE			
US 2004150401	A1	05-08-2004	CN	1504760	A	16-06-2004
			DE	10254660	A1	09-06-2004
US 2002093336	A1	18-07-2002	NONE			
FR 2681432	A	19-03-1993	NONE			